Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

Published by McGraw Publishing Company, Inc.

Volume 70 NEW YORK, SATURDAY, OCTOBER 31, 1914 Number 18

A New Trade Prospect

AN unexpected trade possibility has been opened by the war, due to the prejudice in Germany against English goods. Information has come from several sources that markets formerly monopolized by England would now be wide open to American trade were it possible to get in shipments. Undoubtedly this feeling against the enemy will persist even after the treaty of peace has been signed. It is natural to expect that such a prejudice will not be lasting as against the ability of English manufacturers to undersell American goods. But in trade promotion any man with a meritorious product asks no more than a trial. Certainly price differences, unless very large, will not be taken into consideration by a people filled with hate for a recent enemy. That will afford the American manufacturer the opportunity he is seeking—a chance to show the merit of his goods. The thought is worth bearing in mind as against the time when, the war being over, shipments to Germany can be resumed.

Kansas City Union Station

THE opening of the new Union Station at Kansas City this week marks the virtual completion of one of the most ambitious projects for the unification of passenger terminals ever undertaken in this country. True, the Grand Central Station in New York City involved a larger amount of money, because of its great size and train capacity, the cost of land and the difficulties of carrying on reconstruction under heavy traffic. The same will be true of the proposed Union Station at Chicago. Both projects, however, are expansions of existing facilities. The Pennsylvania Station in New York necessitated the construction of an entirely new entrance to the city, and under the most difficult conditions, but the work was that of one railroad only, with its own interests alone to be served. At Kansas City eleven lines, embracing practically all of the railroads in the city, have buried their differences and worked out one plan serving all. Recognizing the impossibility of adequate expansion at the location of the old union station near the river, they have rejuvenated the Kansas City Belt Railway, cut its grades down to an operating possibility, eliminated its many grade crossings and built a monumental station on a site far more convenient and attractive than the old location. The station itself is an ornament to the city. It has eighteen tracks in place of the six at the old station, and combines the advantages of the stub and the through types by means of a parallel main building and an overhead waiting room projecting across all of the tracks and giving access by stairways and elevators to the platforms. The railroads co-operating in the enterprise are to be congratulated on their disposition in getting together and on the successful completion of the work.

Lining Tunnel with Concrete Pipes

A MOST unusual piece of engineering construction, described on page 474, is nearing completion at Baltimore. The work consists essentially in converting an old brick-lined water tunnel, in which the flow was by gravity, into a pressure conduit operating under a head of 35 lb. per square inch. The novelty lies in the use of huge, separately molded concrete pipe—the largest having a diameter of 9 ft.—to form the new tunnel lining. As the existing tunnel is only 12 ft. in diameter, it is clear that the work had to be carried on in cramped quarters, and, in addition to the difficulties inherent in placing 10½-ton sections of pipe with so little working room, there is the obligation of shutting down operations every few days and using the conduit to deliver water to the city. The valves are then closed and the tunnel drained in order to allow the work of lining to proceed. One of the features of the construction is a specially designed car, which carries the ponderous pipes into the tunnel and by means of adjusting equipment sets them accurately to line and grade. The concrete pipes are of particular interest for they are claimed to rank among the largest precast units ever built. It is also unusual to use reinforced concrete to resist such a large internal pressure as is found in the Baltimore tunnel conduit.

Concrete "Lumber"

CONCRETE "lumber" for shafts and tunnels is now being used on the newer workings in the Minnesota iron range. Economy is not the only reason for its use, although timbering in a mine with a long life, say 20 to 25 years, would require renewals often enough to justify the more durable material. Freedom from fire risk and from the delay in reconstruction should fire occur are the important considerations. Monolithic-concrete shaft lining has been used in mines for some time, but only within the past year has an attempt been made to use the unit method, described on page 478. The first five shafts are being lined with "timbers" made in steel molds, and, in order to save changes in existing equipment standards, the dimensions of the members are the same as the corresponding ones made of wood. Doubtless, in time, smaller sections will be found adequate. One of the first applications of the new members was in an underground pumping station. Here, as in tunnels and drifts, steel sets were erected, behind which the slabs were laid up with cement-mortar joints. Similar application to railroad tunnels and large conduits, either with steel struts or with concrete sets made up of units built on the surface, seems feasible. When space is restricted, water copious and the distance from the portal considerable, the unit idea, already so frequently applied in bridge and building construction, may find a broad field in underground work.

Zone Fares on Street Railways

A SIGNIFICANT paper on the results of applying a zone system of fare collection was presented at the recent convention of the American Electric Railway Association by R. B. Stearns of the Milwaukee Electric Railway & Light Company. The paper was printed in the "Electric Railway Journal" of Oct. 24. It points to a possible way out of the difficulties besetting city traction systems, hitherto obliged to face a steady decrease in net earnings. The decrease has been due to the fixed fare unit applying to substantially the entire municipal area, extended free transfer privileges, improved standards of service, greater operating costs and growing fixed charges. By the institution of fare zones, based approximately on a rate of 2 cents per passenger mile outside the metropolitan district, and limiting each zone to approximately one mile in the suburban district, a basis for rates has been established which is yielding highly satisfactory results. The details of the system need not be outlined here, but it appears that the recasting of the rates has done away with a vast amount of inequality between fares and has been accepted by the public with very little complaint. The average passenger appears willing to pay 7 cents for a journey into the first zone outside the city proper, if he knows that other sections are not treated more liberally. The same feeling exists regarding the subsequent zones. The suburban zone rates were admittedly placed below the estimated service cost by the Wisconsin Railroad Commission in its review (Jan. 2, 1914) of the Milwaukee rates, but the earning power of the suburban lines through growth of territory and traffic was taken into account in the belief that in due course these lines will develop into profitable feeders. It appears, too, that the practical difficulties of zone fare-collection have been pretty well eliminated. As the first marked departure in this country from the flat rate, the innovation at Milwaukee will be watched with interest, particularly since the flat rate, if persisted in, in the face of increasing costs, must inevitably end either in receivership or ownership by the public.

Energy Rates for City Departments

THE importance of making adequate charges for electrical service to municipal departments is emphasized in a decision handed down recently by the Massachusetts Gas and Electric Light Commission. The municipal electric lighting plant of the town of Reading desired to obtain the board's approval of a price of 2 cents per kilowatt-hour for energy delivered to the water department and used in pumping. The Massachusetts statute governing the operation of municipal plants provides that whereas electricity for commercial service may be sold for less than cost with the consent of the commission, it must be sold at cost to municipal departments. The rate quoted above represents the bare cost of producing energy at the plant and falls far below the average cost per unit of output which the law sets forth as the standard to be translated into the price charged. Hence the commission was obliged to dismiss, for lack of jurisdiction, that part of the petition dealing with the rate to the water department. In a municipal plant the allocation of costs between commercial customers and such city or town uses of energy as street lighting and motor service for public work needs to be made with a clear idea of the responsibilities of the consumer and the taxpayer. The Reading decision points out that if it were not for the requirement that energy must be sold at cost to the town departments, all the items of expense upon which the cost is figured might be loaded upon the output to private consumers instead of raising the money through the proper channels of taxation. The commission indicates that the taxpayers have failed to carry their share of the financial burdens of the business. There is no question that a fair apportionment of the actual cost of rendering different classes of service is one of the most important objects to be attained in the successful administration of municipally owned and operated utilities.

Wisconsin State Building Code

COMMENT on the proper limitations of building codes has not been infrequent in this journal. The position has been taken that a code should not be a digest of specifications, covering practically all of the structures to be reached by the measure, but rather should lay down general requirements as to the results to be secured. Unfortunately, most city building codes are now "specification" codes, though in some places, notably in the Borough of Manhattan, New York City, certain phases of building work are covered in the law only by general stipulations, the exact requirements being laid down from time to time in rulings of the building department. These are changed as practice requires, thus making it unnecessary to revise the code every few years.

As is well known, several Middle Western States have recently had State building codes under consideration. Those of Ohio and Illinois have been criticised because they go too much into detail. Wisconsin, however, has proceeded otherwise and in its State building code, formulated by the Industrial Commission and in effect Oct. 15, has confined itself to broad general requirements of fire protection, sanitation and structural safety. Structural details have been avoided, leaving to the ingenuity of the engineer and architect the exact means by which the results which the code requires are to be attained. As a result, a comparatively brief and simple document has been produced. In the editorial on the licensing of engineers, on this page, there will be found a recommendation that instead of licensing engineers laws be passed requiring the approval by the State of the designs for engineering structures. These laws to be complete must include a State building code. The Wisconsin code, therefore, should be in demand as a model for other States. For its brevity and its adherence to general requirements it is to be highly commended.

Industrial Conferences

A GOOD understanding is the first step towards co-operation. That, it may be said, is the idea underlying the Pennsylvania Industrial Welfare and Efficiency Conference, which met for the first time last year. So highly was the conference esteemed by those who participated, that they resolved to hold a second meeting this year, and the Commissioner of Labor and Industry has now issued the call. The purpose of the conference is to enable the employers and employees to work out together the great problems before them with reference to increasing the welfare of the employees and the prosperity of the industries. This has been attempted on a national scale by the National Civic Federation, but, obviously, its deliberations can be participated in by only a comparatively small number of employers and employees. Furthermore, the national body is at a disadvantage in that it must consider problems from very general standpoints and cannot take cognizance of particular local conditions. Its influence should be strong with reference to Federal legislation, but so far as the States are concerned it can merely draw up model tentative laws, leaving their adaptation to the various commonwealths.

Under these circumstances the advantages of a State conference are apparent. Such a meeting can take cognizance of local conditions, publicity through the local press will insure a large attendance, while the reduction in the cost of travel to the State capital or State metropolis will also make for a representative and sizable gathering. It is to be expected that rulings of the Department of Labor and Industry or State legislation will grow out of these conferences, and if such be the case their value is almost beyond estimate. Unfortunately, the people at large do not participate to any great extent in the formulation of our laws. The acts are drawn by interested parties, and intelligent opposition is generally lacking except upon matters relating to criminal procedure, because those qualified to criticise are not taken into conference. In fact, their presence is not desired. The meetings at Harrisburg bring together those with mutual interests in legislation, facilitating co-operative action when enactments are proposed or pending. One-sided legislation, fathered by cliques of employees or employers, is thus less likely.

Licensing of Engineers

A MOST comprehensive yet brief presentation of the arguments against the licensing of engineers will be found in the report of a committee of the Philadelphia Association of Members of the American Society of Civil Engineers, printed on page 484 of this issue. For the last five years the subject has been of perennial interest with, on the whole, it seems to this journal, a growth in the sentiment favorable to licensing. This journal believes, however, that the increase in opinion favorable to legal restrictions on the profession is not due to careful thought but rather to an unconscious growth of the feeling that sooner or later legislators will place under legal restrictions those to whom the design of structures involving the safety of life and property is entrusted. Believing this to be the situation, the Engineering Record suggests careful study of the report referred to above.

The cardinal argument, of course, in favor of licensing is that it will protect the public against the incompetent. The fallaciousness of this argument, however, can be seen by calling to mind the number of ambulance-chasing lawyers, who are a pest to public service corporations, contractors and even private citizens, and to the experiences of thousands of sufferers who have fallen into the hands of incompetent medical practitioners.

Furthermore, the fact that engineers are not employed as are physicians and lawyers—by those unable to learn their professional standing and then, frequently, in emergencies—needs to be considered when the general argument is advanced that if we register physicians and lawyers we ought to do the same with engineers. Engineers, however, are selected at leisure and invariably by those who are in a position to learn as to the competence of those they consider for employment.

The difficulties of enforcing a licensing bill, moreover, are many and serious. One of the most aggravating is the determination of the character of the examination. It must necessarily be sufficiently elementary to allow comparative newcomers in the profession to pass, yet such an examinatiton is not a criterion as to the ability of a man to design a large structure, in which the hazard to life and property is much greater than any work that would be entrusted to a man who could barely pass the stated examination.

In law and medicine there is no alternative, at least none has been proposed, to licensing. Such is not the case in engineering. Whereas it is not possible to examine the work of the physician or lawyer and to insure its reasonableness, propriety or competence, it is not only possible to so control the work of engineers but it is being done in large measure in many States of the Union at the present time. On the Continent of Europe such supervision is customary. In many of our States water purification and sewage treatment plants cannot now be built until the plans have been approved by the State board of health. Other States have laws requiring that the design of dams be approved before their construction is started, while in Wisconsin and Ohio there are State building codes.

This method of guaranteeing the safety of the public, so far as it is affected by engineering structures, is, in the opinion of this journal, not only preferable to the licensing of engineers but far more effective. Furthermore, it has been sufficiently tried in the United States to demonstrate its feasibility, and this journal, therefore, urges upon engineers that their efforts be in the direction of securing legislation that will examine the engineering work itself and not the engineer. Such laws will accomplish all that it is desired to gain by the licensing of engineers and do it more certainly and effectively.

Fatigue in Metals

THE severe effect in metals of repeated stresses above a certain limit is well known. The phenomena have been particularly studied with respect to the effects on steel, the almost universal material of construction where serious stresses have to be met. Fatigue tests, however, have not in general been satisfactory, at least from a commercial standpoint, on account of the time required to make them. Moreover, there is lack of definite knowledge as to the relation between endurance and amount of stress. Some results recently published in England give promise of casting new light on the subject.

The first step toward simplification was the finding of an empirical formula for the number of repetitions necessary to rupture a specimen. This number turned out to be inversely proportional to the fourth power of the excess of the stresses applied over a particular fatigue limit, and the formula was found to apply to torsion, compression and bending to a rather close degree of approximation. The next and most important step was the determination of the fatigue limit by thermal experimentation. It was found that up to a certain limit of stress there is no sensible internal friction which produces rise of temperature, while beyond this limit there is a definite and rapidly increasing rise. The specimen, therefore, is worked under conditions allowing the starting point of rise of temperature to be determined. This point seems to mark the beginning of trouble and by pushing the stresses well up beyond this limit and continuing them until rupture occurs it is possible to define the resistance of the material to repeated stresses by experimentation for merely an hour or two. The method seems a valuable one, empirical though it is, for it is a matter of no little importance to tie up the various relations of repeated stresses so that by a single definite set of experiments the endurance of material can be reasonably well predetermined.

Some Frank Views on Engineering Education

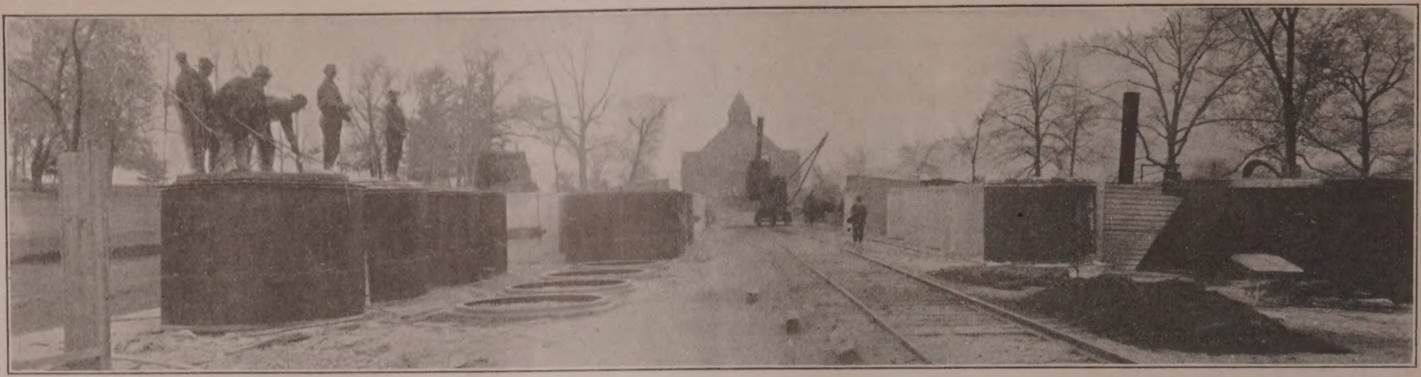
WHATEVER Prof. John Perry, F.R.S., has to say regarding the education of engineers is worth hearing, and his presidential address before the Educational Science section of the British Association for the Advancement of Science is a document which will bear more than casual reading. To start out with, the intimation that a chapter on the science of education is necessarily like the famous chapter on the snakes of Ireland is to bring the listener to attention at the very start, and Professor Perry does not leave the matter right there, but proceeds to show cause for his opinion in a fashion which should make the so-called professional educator stop and consider some of his shortcomings. Not only the professional eminence of the author, but his long and intimate experience with the teaching of engineers, makes his opinions, albeit they may appear to some very radical, a subject for most grave consideration. Those interested in technical education in every country seem at present to be somewhat discouraged at the outlook —not only discouraged at their own, but quick to see and point out the defects in the educational systems of others.

Professor Perry's chief complaint is against the ultra-conservatism of the English public school, which devotes itself, even now, so exclusively to the classics and a peculiar kind of scholastic mathematics as to give little time for the proper grounding of students in those rudiments of science which they will very badly need when training as engineers. He seems to hold a brief against the classics and draws against them an indictment which is difficult to comprehend here, where the schools have long taken a more liberal view of the matter, in fact going perhaps unnecessarily far in the substitution of other and less strenuous courses for the classics of the schoolmen. If the chief fault of the English schools is undue attention to rock-ribbed classical courses, that of the American school is disinclination to enforce a rigorous course in anything. Professor Perry's complaint in the last analysis indicates not so much serious objection to the English public-school courses as thorough dissatisfaction with the way in which the school system involving them is carried out. He points out only too plainly that the curriculum is hidebound—a dismal grind tending to a mediocre uniformity—and that, worst of all, the whole system is built around caste propriety as the central idea. In short, he does not hesitate to say, and in the most outspoken terms, that the English public school has degenerated into a social function, in which the small educational element is conventional and depressing. This arraignment of the old fashioned education tells less heavily against the thing studied than against the conditions of study.

Engineering education, in Professor Perry's judgment, is essentially a democratic education, an education aimed at doing things instead of merely learning things. Hence schools permeated with the idea of caste and social form cannot make for that kind of mental development which lends itself most readily to the pursuit of practical knowledge. But England, in spite of a bad system, has undoubtedly developed under it a great group of men distinguished in applied as well as in pure science. The same is true of Germany, where the education is also along the classical lines so distasteful to Professor Perry. It is really not the classics that are at fault so much as the frame of mind in which the study of them is too often undertaken. One can make just as dismal a failure of scientific subjects, taught out of cut-and-dried laboratory text books, as he can out of wasting time in the fruitless study of grammatical forms. Perhaps the worst possible training for an engineering student is the kind of petty science which deludes him into the idea that he has learned the thing along precise and scientific lines, whereas he merely has acquired, parrot-like, a certain amount of scientific terminology, the relation of which to practical things he has utterly failed to grasp. A boy trained solely on the classics and Euclid, provided these are taught vitally and thoroughly, is in better shape to begin the serious study of technological science.

If the English have stuck too closely to their antiquated methods, we in America have tended to swing too far into other directions, dabbling at many things superficially instead of learning a few things, be they good or bad, thoroughly well. Democracy we have and keen interest in things of practical importance, toward which we are inclined to force the student to run before he has thoroughly learned to walk alone. In education it is the way the thing is done, and not what it is, which is of fundamental value in bringing a young man to the position where he can learn effectively how to do things. Back of it all, in any department of learning, should be the inspiring personality of a really great teacher.

John Perry, located in a barn with what apparatus he could carve out with a saw and jacknife, would mean a great deal more of education to his students than the ordinary man with half a score of assistants and the plentiful resources of a laboratory. It is the lack of John Perrys in classical learning that makes it seem so barren to him. The great presidential address which he delivered in far-off Australia should be studied by every man who is interested in technical education, less because it discloses the weak points in a system here in part outgrown, than because of its bringing to the front the essential spirit that underlies all education, and the basic democracy which is a vital part of the scientific method.



PIPE CASTING YARD, SHOWING STEEL FORMS, BASE PLATES AND LOCOMOTIVE CRANE FOR HANDLING CONCRETE

Nine-Foot, Pre-cast Concrete Pipe for Lining Pressure Tunnel in Baltimore

Water Supply Project Involves Unusual Methods in Molding Huge Pipe and Placing in Cramped Quarters Underground with Special Tunnel Car

WITHIN the cramped quarters of a 12-ft. tunnel more than 4100 ft. of 9-ft. reinforced concrete pipe and 1240 ft. of 7-ft. diameter pipe are being placed as a lining in the pressure conduit between the new filter beds of the Baltimore water supply system at Lake Montebello and the head of the main city service lines at Lake Clifton. An additional 2560 ft. of the same two sizes is being laid in open trench adjacent to the tunnel at both of its ends.

This work is one of the details of the extensive enlargements and improvements which include the new Loch Raven dam and the new filtration plant. The new Loch Raven dam is located only a few hundred feet upstream from the old dam on the Gunpowder River. The water collected by it is led 7 mi. through the rock tunnel which formed a part of the original system and will continue in use unchanged. Under the former plan the water from this rock tunnel was delivered to Lake Montebello, the main reservoir on the northeastern edge of the city, and thence through a 12-ft. brick-lined gravity tunnel to Lake Clifton, a secondary reservoir on the same level about 1 mi. away. From Lake Clifton the water entered the city mains.

Under the new plan the water from the 7-mi. tunnel is delivered to the new filtration plant, located at Lake Montebello, and is then diverted directly to the Montebello-Clifton tunnel without entering either of the lake reservoirs. Connections are retained with both lakes, but they are to be cut off by gate valves and filled with filtered water as a precaution against emergencies at the filter plant. The Montebello-Clifton tunnel is thus utilized as a part of the new system, saving considerable expense in new construction. With the increase in height of the new Loch Raven dam above that of the old dam, the head of water on the tunnels is materially increased, however, and it is necessary to reline the Montebello-Clifton tunnel to withstand the pressure. The future pressure will be about 35 lb. per square inch.

PRE-CAST, 9-FOOT PIPE

The contract for furnishing and placing the concrete pipe for the tunnel lining and trench connections is held by the Lock Joint Pipe Company, of New York, and this company's Meriwether system of interlocking concrete pipe is being employed. All of the pipe units are 6 ft. in length. The 9-ft. diameter pipes have a shell 9 in. thick and weigh about 10½ tons each. The 7-ft. diameter pipes have an 8-in. shell and weigh 7¼ tons. Both types have a straight bell and spigot cast in the ends, so as to make the halved-together, flush lock-joint connection, which is grouted when in place. The reinforcement in each case consists of a framework of belt hoops and longitudinal bars of corrugated steel covered with triangular wire mesh.

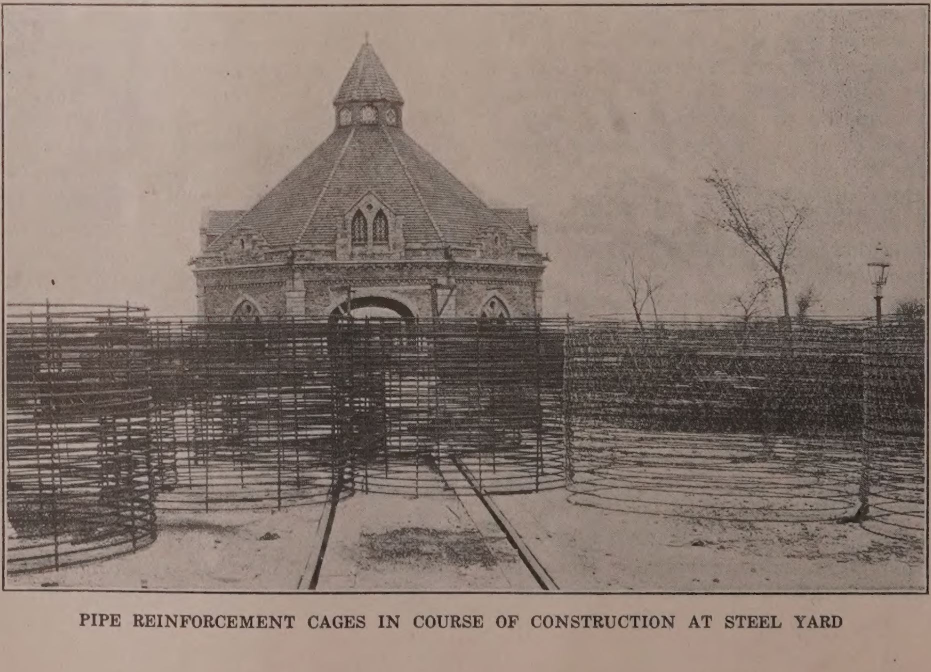
All of the pipe, totaling about 1300 pieces, is cast on the work. Two casting yards and plants have been installed for this purpose, one at each end of the tunnel, close to the shaft. These plants are practically duplicates. In each case, the plant is laid out along a standard-gage track extending back from the mouth of the shaft. Work is started in a steel yard at the outer end of the track and progresses toward the shaft through the successive operations of forming reinforcement cages, mixing, pouring, curing and storing, each operation approaching more closely to the shaft until the finished pipe is within easy handling distance. The track is served by two locomotive cranes, one engaged in the manufacturing operations and the other in transporting and handling the finished pipe.

The steel yard is equipped with a bending table and rolls driven by a small gasoline engine, serving to form the hoop reinforcement of the large size pipe. There is also a large wooden mandrel, around which the triangular mesh for both sizes of pipe is formed. The reinforcing frames are made up complete at this yard and are moved by a specially constructed carrier, which straddles them, to the casting yard, where the forms are set up around them.

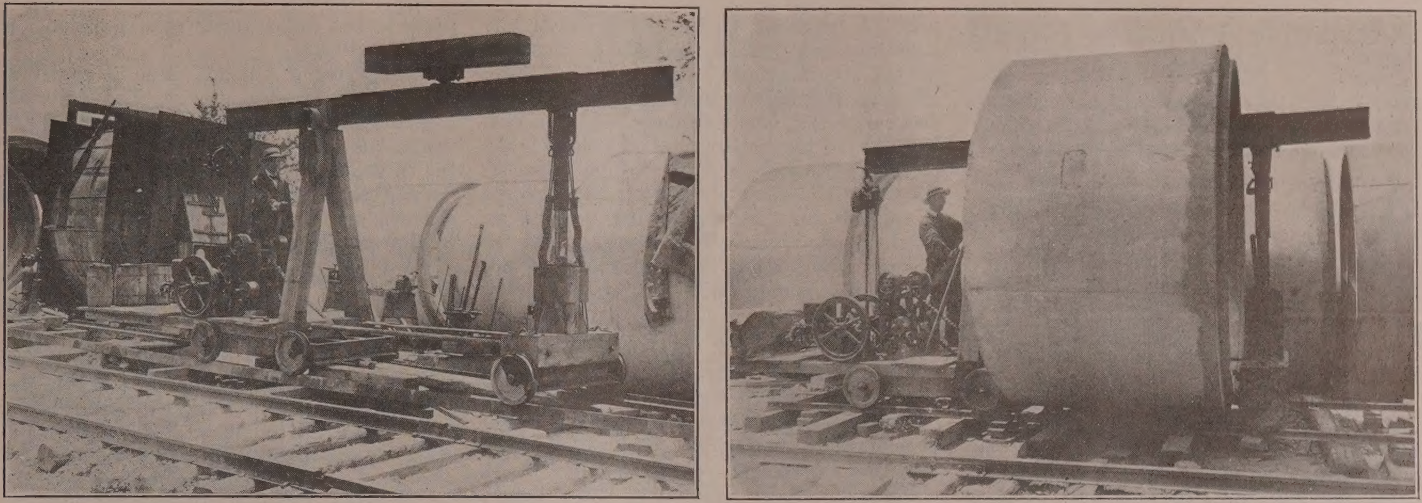
USE OF STEEL FORMS

Steel forms exclusively are employed in casting the pipe. Each form has a solid circular base casting, conforming to the shape of the bell end of the pipe and provided with lugs around the edges against which the sheet steel side forms bear. The latter are in several segmental sections for convenience in handling. They are provided with handles on the outside and with bar locks, so as to connect and disconnect quickly and easily. Pipe forms are set up in single rows on both sides of the track, several being kept continually in advance of the pouring, since the average run is about eight pieces per day.

Concrete is mixed in a battery of two



PIPE REINFORCEMENT CAGES IN COURSE OF CONSTRUCTION AT STEEL YARD

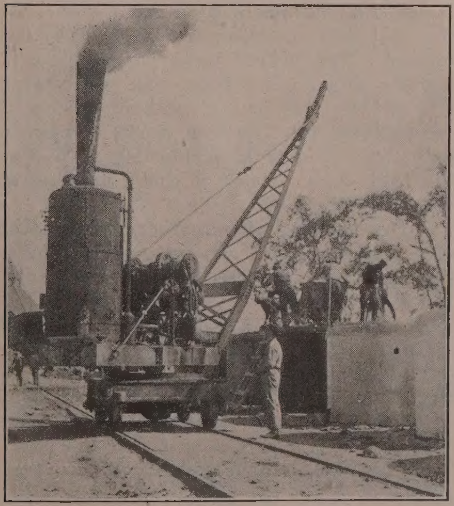


TUNNEL CAR AND METHOD OF CARRYING THE HEAVY SECTIONS OF PIPE—FRONT TRUCK MAY BE RAISED ON FORWARD SHAFT

mixers, placed one on each side of the crane track and between the steel yard and the pouring yard. Both of these mixers are of the "Little Wonder" open-drum type, made by the Waterloo Cement Machinery Corporation, and each is served from a separate cement shed and sand and stone runway. To facilitate quick charging of these mixers special wheelbarrows with small half cylindrical, scoop-shaped bodies were designed by the contractors, so that a man can walk straight up to a mixer, discharge his load head-on into the upturned open drum and back away without turning or delay. In addition, a wooden false end partition, fitting into the barrow body, is used in loading so as to give quick, correct measure for the sand and stone.

Three bottom-dumping concrete buckets are used in connection with the two mixers, one always being in place at each mixer to receive a charge while the third is being handled by the locomotive crane. The crane alternates between the two mixers in taking full buckets, replacing the bucket removed, by the extra empty bucket. As the distance to be traveled by the crane is usually less than 100 ft., the entire plant is thus kept in continuous operation without loss of time.

The locomotive crane dumps the concrete from the buckets on a circular platform, set on top of the pipe form and within the circumference of its inner wall so that its edges come flush with the top edge of the form all around. The concrete is then quickly shoveled into the space between the form walls by laborers on the platform and is tamped with steel rammers.



DELIVERING CONCRETE TO PIPE FORMS

HANDLING PIPE IN TUNNEL

After a group of pipe is finished, a curing shed, consisting of movable wooden sides and ends and a canvas top, is set up around it and steam is turned on from a system of piping laid throughout the yard and supplied from a special heating boiler. The concrete pipe is cured under the steam for 12 hr. and is then allowed to stand for an additional 36 hr. before being handled by the crane or set in place. The forms are stripped after 12 hr. of steaming.

A second locomotive crane, operating near the tunnel shaft, picks up the pipe with the aid of a timber spanner and lowers them into the shaft. Here they are landed on a specially constructed tunnel car which takes them up to the working point underground and sets them in place. Since there is a total clearance of only 18 in. around the pipe within the 12-ft. tunnel and the weight of the units is so great as to exclude ordinary methods of adjusting to line and grade, it was found to be advisable to provide mechanism on this tunnel car for adjusting the pipe to final position before releasing it. It was also necessary for this mechanism to operate entirely within the pipe, on account of the small clearance, which allowed no working room. This was a difficult problem which was overcome with complete success by the special design of the car.

DESIGN OF CAR

The car is equipped with a horizontal arm extending beyond its front, about 10 ft. above the track, and supported at its outer end, which is a little more than a pipe's length away, by an advance two-wheeled truck. This arm has a toggle bearing at its point of support on the car and the support has a sliding base, so as to give it universal motion. When the car is light the forward truck is withdrawn from the rails by means of a jack and is then supported by the arm. In this position a pipe is slipped over the front of the arm and the forward truck then lowered to support the pipe on the car and truck while running up into place. To set the pipe, the forward truck must first give clear way. This is accomplished by transferring the load on the end of the arm to a jack in the pipe which is in place ahead and withdrawing the truck by means of its jack. The toggle and sliding base then permit adjustment to final line and grade.

The complete pipe line through the tunnel is being laid at first with open joints, all of which will be grouted together upon its completion. On account of the necessity of refilling Lake Clifton every 48 hr., the work is interrupted from time to time for periods of one or two days while water is passed through the tunnel. This calls for the removal of the tunnel car and delay of the work until the tunnel is drained again.

This work, it is believed, involves some of the largest pre-cast concrete pipe ever used and the first which is made to operate under a high pressure.

The Montebello-Clifton tunnel lining is being placed under the direction of the Baltimore Water Board, of which Ezra B. Whitman was chief engineer at the commencement of the work and is now consulting engineer.

Washington State Highway Work

THE State of Washington usually spends about $2,500,000 annually in road and highway construction, which is supplied jointly from State and county funds. All construction is either under the supervision of State officials or subject to their approval. Of this total annual expenditure about $1,000,000 is for State roads, which include mountain routes, or roads in sparsely settled districts, and $1,500,000 for permanent highways which bear heavy travel and connect populous centers.

The two main lines of trunk road now nearing completion are the Sunset Highway, from Seattle to Spokane, and the Pacific Highway from Blaine at the north State boundary to Vancouver at the Oregon line. Parts of these trunk lines are built as State roads and other parts as permanent highways.

William J. Roy is State highway commissioner, with headquarters at Olympia, Wash., and James Allen is chief engineer.

HIGHWAY CROSSING ACCIDENTS were discussed by M. A. Dow, general safety agent of the New York Central Lines, at the third annual Safety Congress held in Chicago recently. Mr. Dow found that of 7779 persons who traversed the New York Central tracks at three distinct locations in Syracuse, Detroit and Indianapolis, between 7 a. m. and 5 p. m. one day last December, only 359 looked both ways before crossing.

Alternative Forms of Paving Contracts

Restrict Materials for Important Streets but Allow Open Competition, with Guaranty, for Others —Solution Offered by Engineering Student

A USE for both restricted and open competition—the latter involving a guaranty provision—in asphalt paving specifications is suggested in a paper by Frederic O. X. McLoughlin, of New York City. Mr. McLoughlin's paper, on "The Specification and Selection of Asphaltic Materials," won a prize offered the engineering students of Columbia University by the Barber Asphalt Paving Company, of Philadelphia. His comments were limited to the applications of sheet asphalt. Some of his remarks on the reasons for the development of the long-term guaranty provision and its gradual abandonment are abstracted in the following notes.

The introduction of Trinidad Lake asphalt as a paving material was a bold departure from prevailing highway practice. Further, asphalt for any use was quite untried. It was natural, therefore, to create the guaranty clause. By its provisions the reputation of the engineer was safeguarded, the municipality was apparently relieved of any danger of financial loss in case of failure, and the promoters had the opportunity of demonstrating the worth of their material at their own risk. In the abstract this seems to have been the ideal arrangement, and for the first years of the industry it was no doubt the only possible one.

FAILURE OF GUARANTY CLAUSE

The attempt to shift the entire responsibility to the contractor, however, did not accomplish its purpose. The long-term guaranty clause has proved unsound economically, unjust at times to the contractor and in many cases impossible of enforcement. Throughout the whole period of its use the legality of the clause has been attacked and has been the cause of the defeat or invalidation of many assessments. Where failures have occurred the loss has usually been ultimately borne by the municipality. Naturally the original cost for laying the unknown pavement was materially higher. An instance is cited where, due to the necessity for numerous street openings, a New York City contractor made more profit on repairs and maintenance than on the original contract, the city paying for the materials used prices far in excess of those prevailing at the time of resurfacing.

To-day the uniformity and the records of the asphalts in use many years have apparently almost eliminated the application of this provision. Unfortunately the introduction of numerous new, untried, manufactured or natural "bituminous materials" has prevented its absolute abandonment. Even though the engineer be certain to obtain satisfactory results by use of restricted competition, the method is open to two objections. By limiting competition to those materials whose fitness has been established by long use it fosters monopoly, with the attendant danger of high prices, collusion and fraud; and it makes impossible the introduction through experiment of a material which might prove superior and possibly cheaper, thus delaying the attainment of a satisfactory cheap pavement.

If, on the other hand, the engineer admits all materials, basing his choice on the price bid and trusting entirely to carefully drawn specifications and laboratory tests, he may reduce the first cost but has no assurance that the pavement will not fail. The desire to further the progress of the science of paving and give equal opportunity to all bidders is worthy, but failures in street surfaces are fraught with so much financial loss and inconvenience to the community that it is advisable for the engineer to subordinate this commendable desire.

ALTERNATIVE SPECIFICATIONS

Mr. McLoughlin presents the following suggestions, which embody some original modifications, as a possible solution of the problem: In preparing specifications and awarding contracts special conditions of traffic, character of abutting property and location and importance of the particular street to be paved should be considered controlling factors. Where the street is an important one, and where interruption to traffic through frequent repairs would result in heavy financial loss to the city and to the abutting property owners, the engineer ought to limit materials to those which from long experience have indicated their fitness for use under the conditions Contractors should be compelled to submit certified proof of service-test records, which should be given more weight than consideration of low price.

On all streets of less importance open competition might be permitted, with the use of a modified form of guaranty clause. The contractor in submitting his bid would be expected to submit a price per square yard for laying the surface only, and separate prices for repairing during the first, second and third five-year periods of the life of the pavement, the engineer being free to award the contract with or without the clause involving repairing.

In either case the use of the "reverting specification" recently advocated by H. P. Pullar (see Engineering Record, April 4, 1914, page 393, and May 2, 1914, page 515) is to be recommended. This specification requires that at the time of awarding the contract the successful contractor state what bituminous material he will use, and agree to use an asphalt complying with a specification for that particular class or brand of material. The contractor would have to supply a bituminous material complying with a strict specification and one which could take under consideration the local conditions.

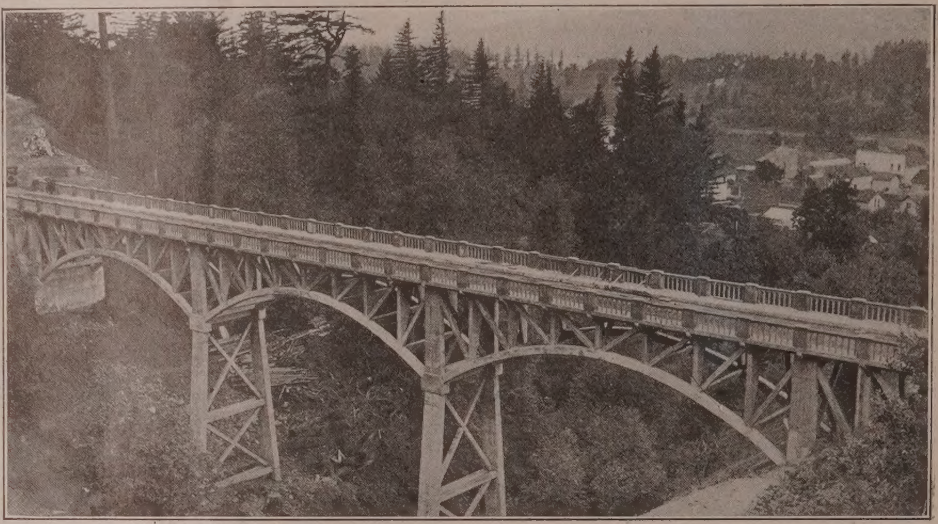
The carrying out of these suggestions would result in the use of tried and safe asphalts on certain important streets; and would also give a broad opportunity for the introduction of new materials, enabling demonstration of their properties by actual service, but with decreased danger of loss to the municipality in case of failure.

A Unique Reinforced-Concrete Bridge

Designed as Trussed Arch Spans, a Minimum Amount of Material Was Required, Resulting in Low Cost

By ALFRED C. REESE
Portland, Oregon

A REINFORCED-CONCRETE bridge, designed after the principles of steel bridge construction, has been built at Latourelle Falls on the Columbia River scenic highway in Oregon. The bridge has the distinction of being the only one of its kind.



TRUSSED ARCH BRIDGE MADE OF CONCRETE WITH HOOPED REINFORCEMENT

Its length is 310 ft. The grade line is 97 ft. above the ground and the top of the railing is 3 ft. higher. The roadway, which is 17 ft. wide, is flanked on either side with a 3-ft. walk. The arch spans are 80 ft., and the lower chord is 20 in. square. The spans are reinforced by hooped steel, giving them great strength.

The foundations are on solid rock. At the east end the piers go 56 ft. into the ground. The arches were poured in continuous runs. The floor slab, containing 250 cu. yd., was poured without a stop of the machinery. The men worked 20 hr. in that run—from 7 a.m. one day to 3 a.m. the next—only a part of them stopping at one time for food.

Above ground the structure contains only 560 cu. yd. of concrete, which makes it the lightest concrete bridge of its size. If the ordinary ideas of construction had been followed a bridge developing the same strength over the chasm would have contained about 1200 cu. yd. of concrete. Hence there is a saving of about $12,000 in concrete, at a moderate increase in the cost of forms.

The bridge, which cost $27,500, was designed by K. P. Billner of the county highway department. It was built by George M. Battersbee, of Portland, Ore.

Soil-Bearing Tests in St. Paul

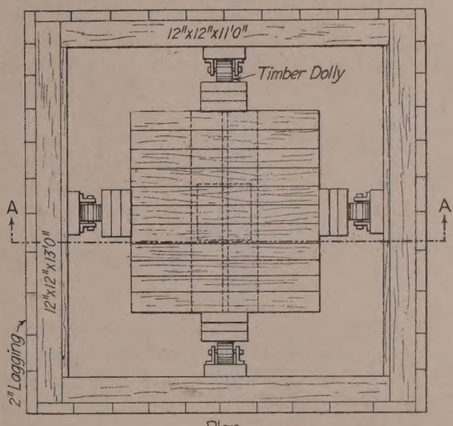
Loading Applied to Develop Passive Pressure in Full Size Pits for Footings of New Twelve-Story Office Building

TESTS of soil beneath material filled in about 40 yr. ago in St. Paul were recently carried out to determine the feasibility of supporting a new twelve-story office building which would impose a load of 4 tons per square foot. The structure is being erected on a 235 x 290-ft. space at Jackson and Sibley Streets between Fourth and Fifth Streets jointly by the Northern Pacific Railway Company, the Great Northern Railway Company and the First National Bank. Doubt was felt as to the bearing value of the material under the filled area on the Fourth Street side so that tests involving loads as great as 8 tons per square foot were made. The material under the footings, about 15 ft. below the surface, was a mixture of coarse sand and comparatively small gravel with about 10 per cent of clay. Possibly 5 per cent of the gravel would not pass a 1½-in. ring and the remainder was graded down to pea gravel.

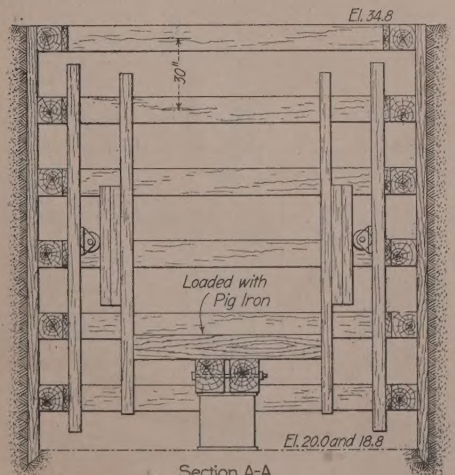
PREPARATIONS FOR TESTS

Tests were carried out in a full-size excavation down to the proposed bottom elevation of the footing, the pit being sheet-piled and braced. Material at the bottom was leveled and a block 24 in. square placed in the center with a 1-in. pipe extended to the top of the pit to provide a bench on which to take levels. Pig iron was loaded onto the 6 x 6-ft. platform. On account of the small size of the block a failure was reported on the test. The material was displaced and forced up outside of the base.

A second test was then carried out with a block 4 ft. square, the remainder of the pit being covered with 2-in. planks counterweighted to 475 lb. per square foot to meet as nearly as possible the actual conditions that would exist were the building completed. There was noted only a ¼-in. total settlement due, it is thought, to the block reaching its proper bearing.

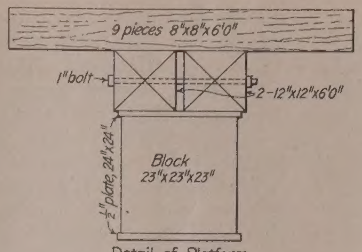


Plan

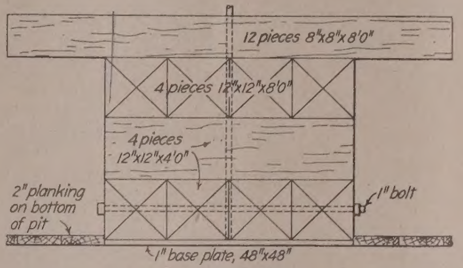


Section A-A

PLAN AND SECTION OF TEST WELL



Detail of Platform Used in First Test



Detail of Platform Used in Second Test

PLATFORMS FOR FIRST AND SECOND TESTS

TEST WITH 2-FT. BLOCK

Time	Load, tons per sq. ft.	Settlement, inches
May 21, 9.00 a. m.	No load	0
May 22, 9.00 a. m.	4	3/16
May 22, 3.30 p. m.	6 1/2	1 7/16
May 23, 1.30 p. m.	6 1/2	6 1/2

Inspection of the material under the block after the test showed no indication of displacement. A ½-in. layer of cement which had been placed to level the block was cracked only in a few places. To obviate any danger of the pig iron shifting or tipping over planks were placed on the four sides of the load and timber dollies attached to the sides of the pit leaving ⅛-in. clearance.

TESTS WITH 4-FOOT BLOCK

Time	Load, tons per sq. ft.	Settlement, inches
May 29, 2.00 p. m.	No load	0
30, 2.00 p. m.	1	1/16
June 1, 7.30 a. m.	2	3/16
2, 8.00 a. m.	4	0
3, 7.30 a. m.	4	0
4, 8.00 a. m.	6	0
5, 7.30 a. m.	6	0
6, 7.30 a. m.	8	0
Total settlement		1/4

A test similar to the second one was repeated on the opposite side of the building site where the material was all clean coarse sand. A total settlement of ½ in. occurred during the first part of the loading, the later readings up to 8 tons per square foot showing no further settlement.

The tests were carried out under the direction of E. B. Morden, superintendent of construction. Grant Smith & Company are contractors for the Railroad Building. Charles A. Frost is the architect.

CINDERS from a forest fire in tree tops in northern Washington have been carried a distance of 20 mi., according to the records of the U. S. Forest Service.

Opportunities for Trade Expansion in Peru Not Bright

Correspondent Discusses Status of Engineering Work—Small Demand for Equipment and Supplies—Lack of Capital Throttles New Enterprises—No Investment, No Purchase

FROM a correspondent in Lima the Engineering Record has received the following opinion concerning the status of engineering works in Peru, the field open to American manufacturers of engineering equipment and supplies and the general condition of finances in that country:

NO CAPITAL FOR NEW WORK

"The financial organization of this country is such as to make it depend in a greater degree upon European than upon American financial conditions. The war in Europe has paralyzed commerce and industry. There are few engineering works of importance, and the country is rather in the stage preliminary to active development, than in that coincident with the construction of works. Thus many irrigation works have been planned, but no capital has been secured and negotiations are still pending. The war has eliminated European capital from the field of these negotiations, but has produced a crisis in the country which accentuates the Government's financial embarrassments, places additional burdens upon its already heavily charged credit and makes the undertaking of large public works more difficult than formerly.

"If any irrigation works are undertaken at this time they must be undertaken with American capital. But the successful carrying out of the Government's policy demands the establishment of agricultural banks. The present banking situation is controlled by European houses which have so far resisted with successful cleverness the ingress of American bankers. This whole matter of irrigation enterprise is being investigated by two prominent American firms, resident in New York, and if they succeed in arriving at a decision of positive import they will naturally buy American products, and would be at once in a position to avail themselves of the information you seek to provide.

WATERWORKS NEEDED

"Waterworks supplies have, as a rule, come from England. Designs for new town supplies exist for Lima and suburbs, with a population of 200,000; for Chiclayo, with a population of 15,000, and for one or two other towns of small size. Many ports and small towns along the coast and in the Sierra are in need of new systems, some of them in fact never having possessed a water supply in the modern sense.

"The immediate and probable demand for engineering supplies and machinery would be limited chiefly to the needs of these two branches and to railroad construction, but there is little immediate promise of activity. Lima is badly in need of water supply improvement, in which English capital has apparently more chance than American. Owing to the present high price of sugar, the sugar estates of the coast may extend their irrigation systems.

RAILROAD CONSTRUCTION AT STANDSTILL

"Railroad construction is carried on by the Government or by the Peruvian Corporation, an English company owning or operating practically all the railroads of the country. On these roads American rails and English rolling stock has characterized recent transactions, but the principal railroad, the Central, a trans-Andean line, has American equipment principally. Railroad construction is also paralyzed now. It is the opinion of the majority of business men, engineers and Government officials that no important works of any kind will be undertaken during the present year, and the demand due to existing works and enterprises is small.

Cement

"The present consumption of Portland cement is about 12,000 bbl. per year; this is all imported. The average price for first-class American Portland on board in the ports of the coast is about $2.75 per barrel, U. S. currency, bought in lots of a hundred barrels or more. Landing charges are high—frequently 50 cents gold per barrel—and railroad tariffs are also excessive, ranging from 7 to 15 cents per ton-mile. A concession exists giving to a local company the exclusive privilege to manufacture cement, but the plant has not yet been erected. This would result in an inferior brand and probably slight reduction in selling price. The average price in Lima is $3.60 per barrel for first-class American Portland.

"In municipal construction adobe is almost universally used. For this a light frame work of lumber is constructed, containing the window framing and doors. Then the walls are built up of mud and straw or manure mixed with straw. In the better principal residence districts a light facing of gypsum plaster (plaster of Paris) is laid on facades and exposed surfaces outside. Recently some concrete buildings, with small percentages of steel distributed haphazard, have been erected in the business sections of Lima. The adobe structure will probably predominate for many years. It is cheap, abundant, easy to erect with unskilled labor, has a fairly good resistance to fire and resists earthquake shocks apparently better than brick and mortar walls. Its disadvantages are more than offset at present by these considerations. Lumber is used also for boat-building and for sheds and warehouses along the coast.

Uses of Machinery

"The chief use of machinery is for mines, for grinding sugar, ginning cotton, plowing, for pumping water and for generating power. England and Germany are principal suppliers of machinery for such purposes. The English type of steam plow is preferred because, although more costly, it is of more certain effect in heavy soils. English sugar machinery also is nearly universal. American cotton ginning machinery, however, is the only kind known here, and American pumps and power machinery are gaining ground.

American Enterprise Needed

"Peru is a poor country, with an annual income of $16,000,000 and a national debt of $32,000,000, United States currency. Agriculture and mining are its chief industries. The population many years ago was estimated at 4,000,000, by far the greater part of which is of Indian blood. Enterprise, either public or private, is rare. The sale of American materials and machinery must depend upon the development by American capital of the natural resources, and upon the development by American enterprise of a better class of population. Americans cannot permanently sell their manufactured products in Peru unless they come upon the ground personally with men, money and organization, to change the economic conditions in general, investing capital in public utilities and private industries, building up a community of American interests within the country and facilitating the growth of those interests with a banking system adapted to foreign intercourse.

"Capital invested in foreign improvements returns, in large part, to the mother country in payment for supplies. This is the principle that England never forgets. Without the investment upon the one hand there can be no purchase upon the other, and as there is no capital in the country, foreign capital must be employed for development. If this capital is not American, neither will the materials needed in development be American as a rule, although the present European conditions may create a temporary demand. An increase in the permanent demand cannot be created without the investment of capital in ways that increase population and wealth within the country."

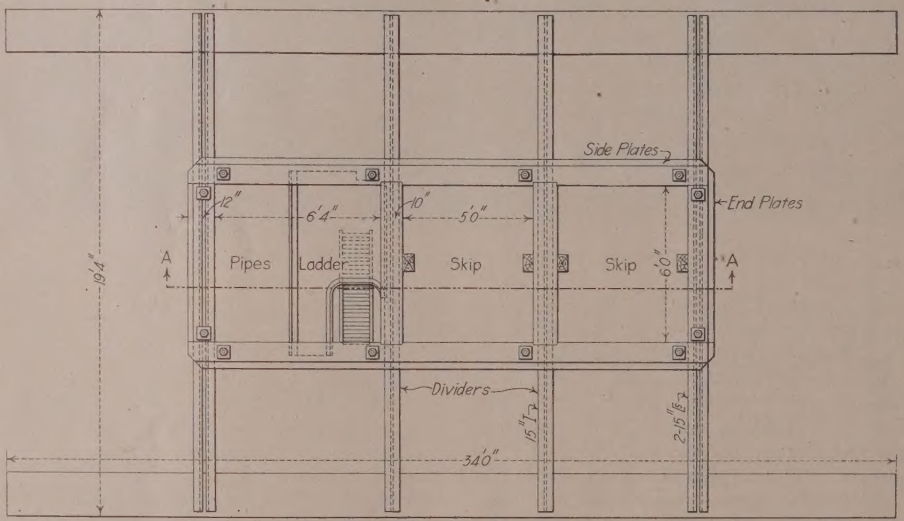
Concrete "Lumber" for Mine Shafts

Shaft Sets, Stuttles, Lath and Blocks Made in Cement Products Plant at Hibbing, Minnesota, Are Shipped to Various Districts on the Mesaba Iron Range

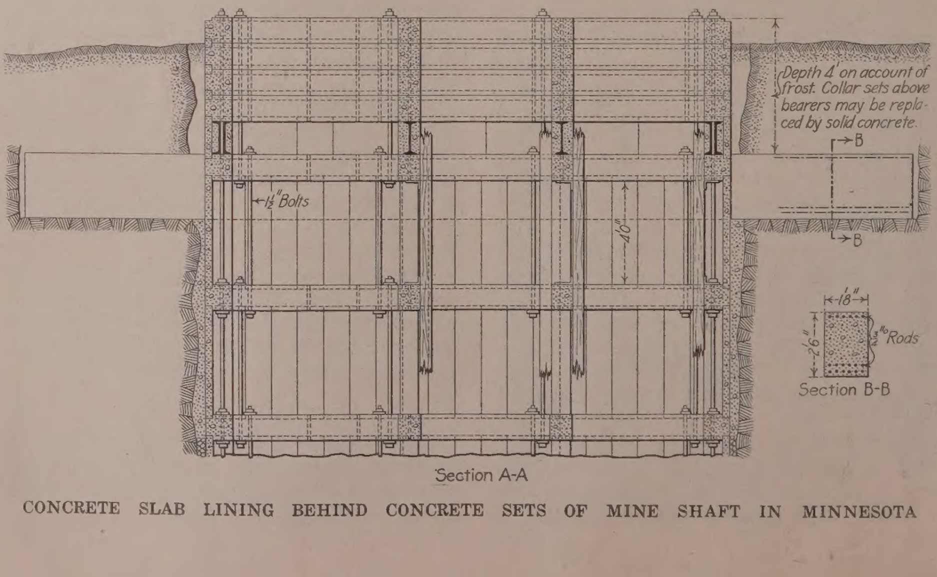
FIVE shafts on the Mesaba Iron Range under construction last summer by the Oliver Iron Mining Company are lined with concrete sets and five new power plants to operate the shafts are being constructed of concrete building blocks. These shaft sets and building blocks are made at a central cement products plant at Hibbing, Minn., and shipped to the different mines, a maximum distance of 90 mi. The plant consists of a crusher, bucket elevator, revolving screen, one concrete mixer, one concrete block machine, a pocket divided into three divisions, one for sand, one for gravel, and one for "over-size," two steam rooms, and a casting room equipped with an overhead traveling crane.

Handling Concrete Materials

Cement required is delivered in railroad cars on a trestle at an elevation of 21 ft. above the casting-room floor, and is unloaded directly from the car onto the cement storage floor. Sand and gravel are obtained from stripping the Sellers' Pit, a distance of about 1 mi. from the plant. This material is loaded on stripping cars with a steam shovel and hauled to a large stockpile near the plant. From the stockpile the material is again loaded on small cars,



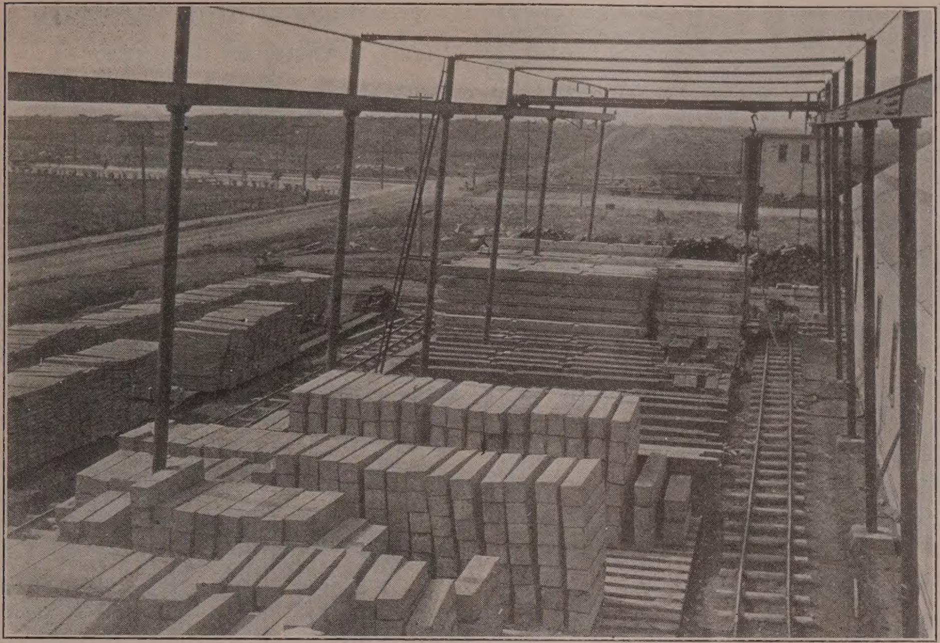
Plan of Bearers at Surface


Depth 4' on account of frost. Collar sets above bearers may be replaced by solid concrete.
B
B
1½" Bolts
4'0"
1'8"
2'6"
¾" ⌀ Rods

Section B-B

Section A-A

CONCRETE SLAB LINING BEHIND CONCRETE SETS OF MINE SHAFT IN MINNESOTA



YARD FOR CASTING AND STORING CONCRETE MEMBERS FOR MINING SHAFTS

trammed by hand and dumped into the crusher. The product from the crusher is discharged onto the bucket elevator which raises it to the cylindrical revolving screen perforated with 3/8-in. diameter holes in the first section and with 1-in. holes in the second. All aggregate passing the smaller holes is termed sand and that passing the 1-in. holes is termed gravel. "Over-size" is returned to the crusher for recrushing or it may be used for foundation work.

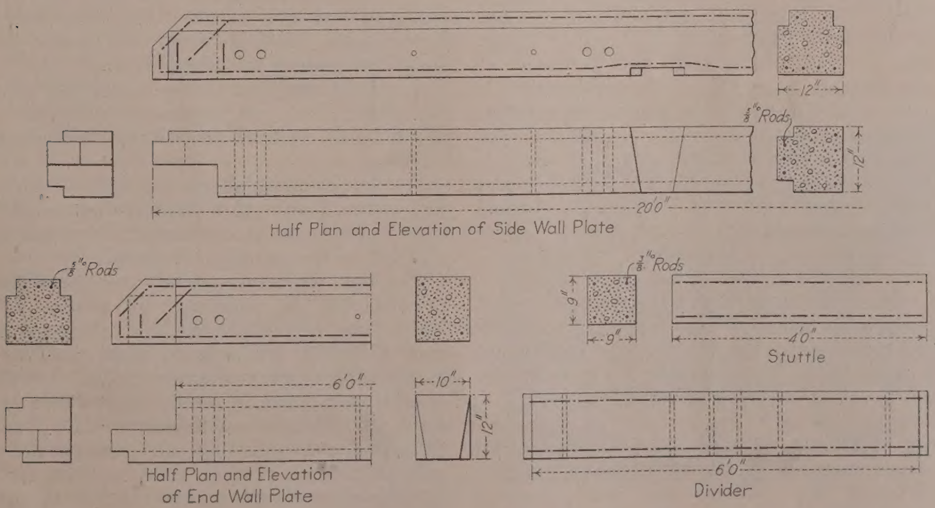
From the bin the aggregate is loaded from spouts and brought to the mixer in a charging car divided into three sections to hold the required amounts of sand and gravel. Cement is poured into the car from sacks before discharging into the mixer. The mixed concrete is poured from the mixer into a distribution car; thence through a chute to the block machine, or it is dumped directly from the mixer through a chute into a car on the mixing floor and trammed by hand to the casting room where it is poured directly into the steel forms for making concrete sets.

SHAFT MEMBERS

The shaft members are cast in steel forms to shapes of exactly the same dimensions as timber sets for the same size of shaft. Thus no changes are necessary in the various standards of equipment worked out in the different wood-lined shafts which are already constructed. The reason for using concrete sets instead of timber is to eliminate fire risk and to insure permanence. In the ordinary wood-lined shafts it has been found that the timbers soon decay, and after 4 or 5 yr. the shaft requires continual repairs.

Each shaft set consists of two wall plates, two end plates, each 12 in. square, two dividers, 10 in. wide and 12 in. deep, eight 9 x 9-in. stuttles, and fifty-six 4 x 12-in. slabs for lining. The sets are spaced on 5-ft. centers. Each set is hung from the one above by twelve 1½-in. bolts. At intervals of a maximum distance of 80 ft. steel bearers, consisting of a single 12-in. I-beam under each center divider and two 12-in. channels (spaced 2 in. back to back to allow the hanger bolts to pass through) under the end plates, are placed to carry the weight of all sets above. In calculating the weight to be imposed on these bearers no account is taken of the side pressure from the shaft.

Starting at the collar of the shaft, the first bearers are supported by two reinforced-concrete beams, 20 in. wide by 30 in. deep. These beams are placed not less than 4 ft. underground to form a foundation to carry the first section of shaft lining.



Half Plan and Elevation of Side Wall Plate

Stuttle

Half Plan and Elevation of End Wall Plate

Divider

DETAILS OF THE SEPARATELY MOLDED CONCRETE "LUMBER" FOR SHAFT BRACING

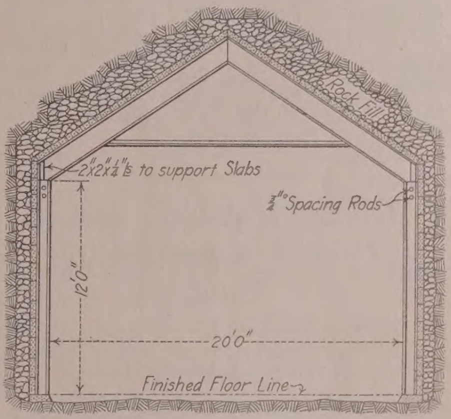
The cost of concrete sets laid down at the shaft ready for lowering is about twice as much as for timber sets, and the labor of installation is increased but slightly, due to the additional weight.

The five concrete-lined shafts and power plants are located at the following mines: Philbin mine at Hibbing, Duncan mine at Chisholm, Wanless and Shiras mines at Sharon, and Minnewas mine at Eveleth. Each of these shafts is about 200 ft. deep.

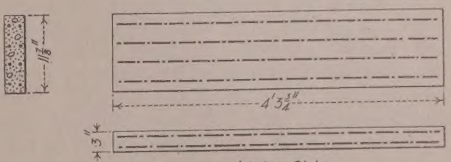
UNDERGROUND PUMPING STATION

The company has constructed successfully an underground pump station at the Leonidas mine, consisting of steel supports spaced on 4-ft. centers and concrete slabs for lining the walls and roof. The station is 438 ft. below the surface and accommodates two crank-and-flywheel Prescott Corliss pumping engines and one compound direct-acting Prescott relay pump. The steel sets comprise uprights of 8-in. I-beams placed on 4-ft. centers, 15-in. I-beam rafters and a bottom chord of angles 2 ft. above the top of the uprights to increase the head room. All field connections are bolted. Concrete slabs, 4 in. thick, 12 in. wide and 4 ft. long, reinforced both sides for a pressure of 350 lb. per square foot, are placed horizontally and backed with broken rock tamped in. At the top of the uprights blocking is carried back to solid rock.

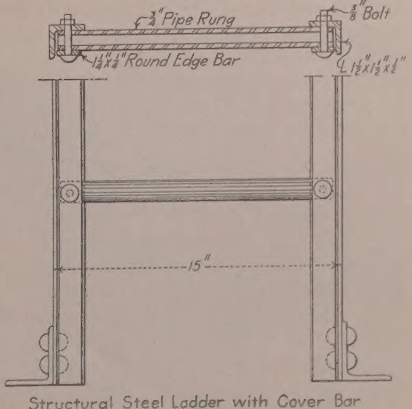
Waterproofing was accomplished by dip-



UNDERGROUND PUMPING STATION

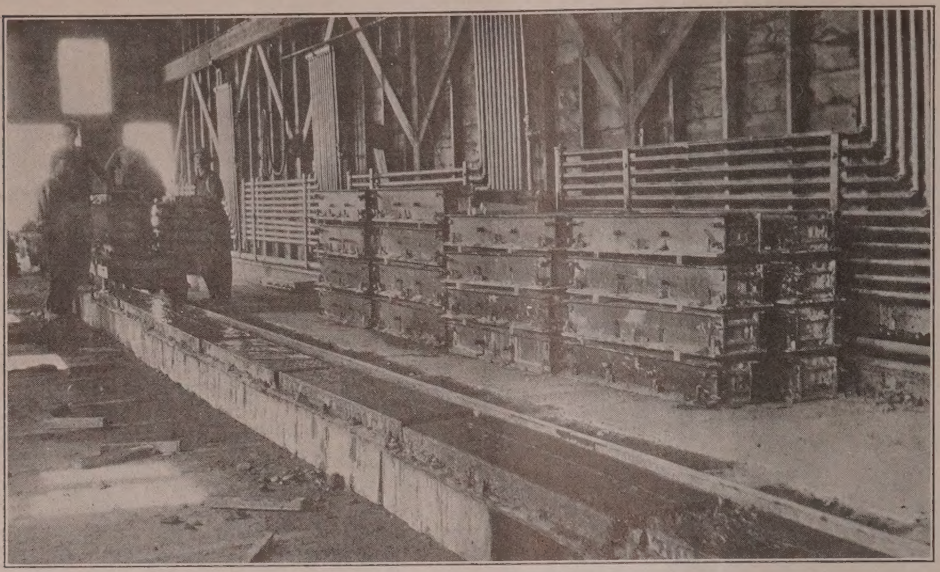


Lining Slab



Structural Steel Ladder with Cover Bar and Renewable Rungs

DETAILS OF LADDER AND LINING SLAB



CONCRETE POURING ROOM FOR SLABS AND MINE SHAFT SETS

ping the slabs on the surface in hot tar and setting them in neat cement. Tar paper was used to carry off the water, which fell in sheets, until the cement could set. Two coats of white cold water paint were applied after the slabs were in place. A recent inspection disclosed a perfectly dry underground station.

The cement products plant is operated under the supervision of the general superintendent of the Hibbing District. Work at the shafts is directed by the general superintendents of the districts in which shafts are located. Designs were prepared in the office of the chief engineer of the company at Duluth, Minn.

Record Rainfall Which Caused Kansas City Floods

During September City Was Deluged with Fall of 16.17 Inches—Former Record Was 10.92 Inches in May 1910

By ROBERT S. BEARD
Kansas City, Missouri

SINCE the publication of the article describing the damage done by the recent floods in Kansas City, Mo., in the Engineering Record of Sept. 26, page 349, it has been possible to collect additional data on the amount and intensity of the rainfall. During September the city was deluged with 16.17 in. of rain, most of which fell in four excessive storms—7.03 in. in the storm of Sept. 6 and 7; 2.11 in. on Sept. 10; 3.59 in. on Sept. 15; and 2.13 in. in the storm of Sept. 21 and 22.

The average annual rainfall for the last 20 yr. has been 37.37 in. The second highest monthly rate is 10.92 in. for May, 1910. In September, 1913, 4.14 in. fell. The accompanying table shows some interesting comparisons: 5.93 in. of rain fell during the storm of Aug. 23, 1906. This storm, which caused the last Turkey Creek flood, is the only rain on the local records comparable with the rains of Sept. 7 and 15.

MAXIMUM AVERAGE RATES OF RAIN IN INCHES PER HOUR

Period, minutes	Kas. City rain curve	Sept. 7, 1914	Sept. 10, 1914	Sept. 15, 1914	Sept. 21, 1914	Aug. 23, 1906
5	4.67	7.68	4.80	7.44	2.64	6.84
10	4.20	6.06	3.66	6.96	2.16	6.72
15	3.82	5.04	2.68	6.28	2.08	6.60
20	3.50	4.14	2.49	5.55	1.92	6.45
30	3.00	3.12	1.83	4.64	1.90	6.14
40	2.62	2.12	1.50	3.85	1.65	5.68
60	2.10	1.97	1.40	2.94	....	4.78
80	1.75	1.87	1.42	2.56	....	4.08
100	1.50	1.66	1.24	2.11	....	3.44

The first rain started at 11.40 p. m., Sept. 6, and 6.94 in. of rain fell in the next 10 hr. and 10 min. It was a series of local thunder showers which traveled slowly in a northeasterly direction. All of the exceedingly heavy short period rates shown in the table occurred during the first half hour of the storm. The heavier longer period rates occurred after 6 a. m.

The two smaller rain of September might reasonably be expected in the same year, but that two such rains, and, in addition, two rains which break the records for 20 yr., should occur in the same month, is out of all reason.

Approves Schoharie Water Supply Project for New York

PERMISSION has been granted by the New York State Conservation Commission to the Board of Water Supply of the City of New York to impound the water of Schoharie Creek and divert it into the Ashokan reservoir. The way is now open for New York City to develop the second of the several supplies originally contemplated in the plans for the Catskill aqueduct. The Schoharie development involves a dam near Prattsville, in Greene County, and a 10-mi. tunnel from this structure to the Esopus watershed. In developing the new supply provision will be made for furnishing a limited amount of water for local purposes. It was announced this week at the offices of the New York Board of Water Supply that preliminary work, including borings and surveys, would soon be begun at the Schoharie watershed.

BUILDING CONSTRUCTION IN MEXICO CITY, suspended some time ago on account of the governmental chaos, and the consequent impossibility of communicating with the north and obtaining material and fuel, is reported to have been resumed on a number of buildings. The material most needed was cement, of which not a pound could be brought in. Dealers are now receiving daily orders.

Proposed Future Sanitary Policy of Racine

Abstracts of Conclusions Drawn by John W. Alvord after Extensive Investigation

FILTRATION of Lake Michigan water and inland treatment of the sewage have been recommended to Racine, Wis., as the future policy to be pursued to protect its sanitary conditions. John W. Alvord, of Alvord & Burdick, consulting engineers, of Chicago, has recently delivered to the city a 200-page report on the subject, which has been in course of preparation for over a year. Bacterial and chemical work, embracing an examination of the water supply, Lake Michigan adjacent to the city front, Root River, the harbor and city sewage, was carried out with the assistance of Prof. Edward Bartow, director of the Illinois State Water Survey. Gagings of sewage flow, the flow of the river, the lake drift and temperature were ascertained and a topographical survey of the city compiled under the direction of the city engineer, P. F. Connolly.

Six policies are compared and methods for carrying out the one recommended outlined. The problem at Racine is that of many lake cities situated at the mouth of a river flowing into the lake, from which the water supply is derived. The river, harbor and the lake itself finally become contaminated by the increasing population.

CONCLUSIONS

Some of Mr. Alvord's conclusions are as follows:

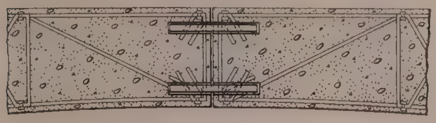
1. That the water supply, controlled only by sterilization, is a menace to health.
2. That an area of pollution extending out 2½ mi. exists in front of the city, but the boundaries are variable depending on the wind, lake drift, outflow of the river and of storms stirring the bottom of the lake.
3. That lake oscillations and river floods carry pollution from the harbor into the lake.
4. That sewage stagnates in the river and harbor during low river flows to the great annoyance and discomfort of the industrial population and general detriment of the welfare of the city.
5. That once in the lake wind is the most important factor in determining the direction of the drift, which is markedly southern, although the direction is frequently reversed. Three-mile currents are produced.
6. That the topography and the existing sewer system are such that the dry-weather flow can be diverted inland and treated before discharging into Root River.
7. That pending the construction of a filtration plant the intake, if removed to Wind Point, will afford the next best alternative.
8. That filtration of water is cheaper and more effective than sewage disposal, but that neither can be omitted in this case on account of the storm water flow.

For the combined systems an expenditure of $947,000 is necessary by 1918. The waterwork improvements are estimated to cost $150,000, the sewage plant $385,000, and the intercepters the remainder. Annual operation expense is estimated at $8385 for the 6,000,000-gal. filtration plant and $12,880 for sewage disposal. Enlargements will be necessary after 1920 or 1925, raising the annual costs by 1940 to $15,000 and $26,640 for water and sewage respectively.

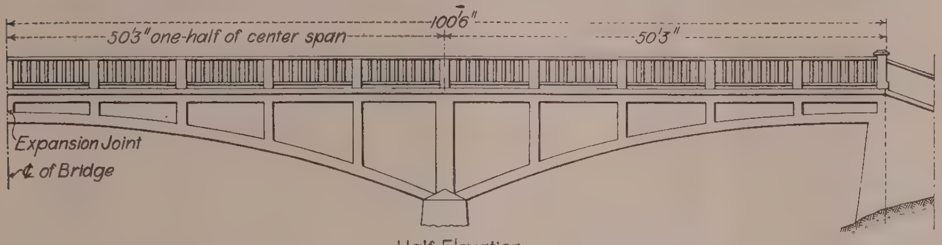
Cantilever Bridge Built to Resemble Concrete Arch

Design Providing for Arch-Shaped Girders with Expansion Joints at Center Is Accepted in Competition for Structure 201 Feet Long Across Rouge River, Michigan

DESIGNED to simulate an arch, the reinforced concrete bridge spanning the Rouge River in Wayne County, Michigan, is, in reality, a cantilever structure, 201 ft. long between abutments. Anchor arms 50 ft. 3 in. long, connected to but not built monolithic with the abutments, form the end spans, and cantilever arms, extending 50 ft. 3 in. from the piers toward the middle, form the center span. The cantilever design, according to an article in the October "Bulletin" of the Universal Portland Cement Company, was chosen because of the unsatisfactory foundation conditions and the possibility of a washout made it desirable to build a structure which would be as little as possible affected by movements of the piers. Existing examples of similar bridges at Flint and Palmyra, Mich., and Toledo, Ohio, show an excess of steel over the arch type of from 10 to 15 per cent, but a saving in concrete as the abutments are much lighter. The elimination of the earth fill between spandrels also tends to cheapen the construction.



Detail of Expansion Joint



Half Elevation

HALF ELEVATION AND EXPANSION JOINT OF ARCH-SHAPED CANTILEVER BRIDGE

The 18-ft. roadway of the bridge is designed for a load of 20 tons on two axles 11 ft. apart. On either side there is a 3½-ft. cantilevered sidewalk. A concrete balustrade of simple design forms the railing. Its members are separately molded, joined by heavy posts at intervals of 10 ft. and provided with expansion joints over each post. The headroom at the center of the middle span is 15 ft. above normal water stage. No special surface finish was employed and only such precautions were taken as are common in careful form work.

Both piers are 15 ft. high, 7½ x 26 ft. in plan, and rest on wooden piles which they encase to a point below low water. Each abutment is 4 ft. thick at the bottom and has two wing-walls, 10 and 22 ft. long on the down and upstream faces respectively.

DESIGN OF GIRDERS

The supporting girders, designed for a live load of 2500 lb. per linear foot, are 12 ft. deep at the piers, 3 ft. at the thinnest portion and are 30 in. thick. The lower reinforcement in the girders extends into the piers. Abutting ends are not attached at the center of the middle span nor are they fixed at the abutments. Above the piers the girders are tied together by 24-in. walls serving to distribute the load equally over the top of the pier. At the tops of the girders there are 16 x 26-in. floorbeams, 5 ft. apart, supporting the floor slab which is 6 in. thick at the curb lines and crowned 1 in. to form the finished roadway. Alternate beams are extended through the girders and form cantilevers supporting sidewalks and railings.

EXPANSION JOINT

An expansion joint at the center of the middle span permits the two abutting arms to move longitudinally, but prevents lateral or vertical movements. It consists of two 3-ft. pieces of 2½-in. steel shafting each inserted in two 1½-ft. pieces of 3-in. gas pipe embedded in the concrete. There is no apparent deflection at this point under live load. Sheets of 3-ply tar paper were placed on top of the abutments before the girders, beams and floors were deposited, so that the half spans are hinged thus permitting a slight movement under changes of load and temperature. Forms for girders, beams and floors were then placed for the first span and concrete poured up to the line of the roadway floor in one operation. Forms for curbs and sidewalks were supported on the bridge floor. The second span was then concreted in the same manner as the first span.

The structure was built for the Board of County Road Commissioners of Wayne County, Michigan, of which Edward N. Hines is chairman. Designs were submited in competition, the one accepted being drawn by the Wynkoop-McGormley Company, of Toledo.

EXPLOSIVES produced in the United States during 1913, according to statistics issued by the U. S. Bureau of Mines, amounted to 463,514,881 lb., as compared with 489,393,131 lb. for 1912. This production is segregated as follows: Black powder, 194,146,747 lb.; "high" explosives, other than permissible explosives, 241,682,364 lb.; and permissible explosives, 27,685,770 lb.

Tractor Used for Plowing Macadam Highway

Area 1¼ Miles Long, 20 Ft. Wide, and 12 In. Deep Torn Up in One 8-Hour Day in Building Illinois Concrete Road

IN building 24,000 ft. of concrete road on Milwaukee Avenue, near Niles Center, Ill., the existing 14-ft. hard macadam highway was plowed to a depth of 12 in. by a tractor. Moving at its intermediate speed of 2½ mi. per hour the tractor covered an area of 1¼ mi. long and 20 ft. wide in one 8-hr. day. This, according to the contractor, equalled the work of 100 horses. The average daily operating cost for plowing and grading was $16, which included $5 for 45 gal. of gasoline per day at 11 cents, and $11 for labor, $5 of which went to the engineer on the tractor, and the remaining $6 to the two plowmen.

CONCRETE WORK

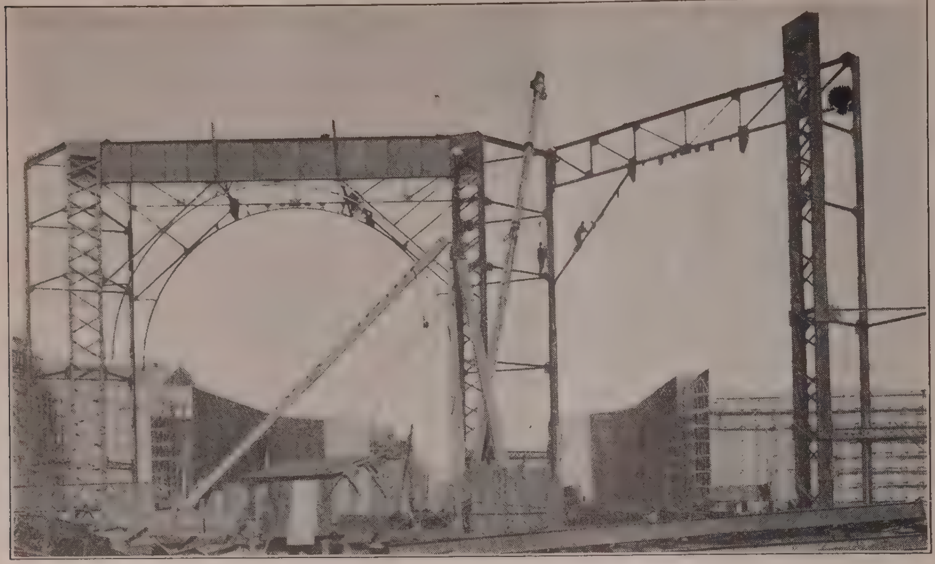
The new concrete road is 18 ft. wide, with 6-ft. earth shoulders. The concrete is laid on the flat sub-grade in one course, 6 in. at the sides and 8 in. in the center thus giving a top crown of 2 in. The mix consisted of 1 part Marquette Portland cement, 2 parts sand and 3½ parts gravel. The gravel ranged in size from ¼ to 1½ in. The concrete was placed at an average rate of 800 yd. per day. Clastite joints are spaced every 100 ft. Near the midpoint of the work a well and reservoir were located. One pump raised the water from the well to the reservoir and a second pump forced it from the reservoir into a 2-in. water pipe which carried the water 12,000 ft. from the well in both directions.

The equipment used in building the road consists of a ½-yd. Koehring mixer, a three-speed, 40/65-hp Bullock tractor, and an Austin roller and 7-ft. grader. The road is being built jointly by the County and the State. W. S. Walters, of Glencoe, Ill., is the contractor.

Kansas City Union Station

OPENING the union station at Kansas City this week follows continuous work since 1910 on terminal improvements costing $45,000,000. On the front cover of this issue is shown a view of the station and uncompleted train yard, and on this page is another view from the street. Articles describing features of this improvement have been printed in the Engineering Record of Nov. 2, 1912, page 480, that of Aug. 30, 1913, page 228, and that of Oct. 24, 1914, page 461.

VIEW OF UNCOMPLETED KANSAS CITY UNION TERMINAL FROM STREET



DOME PIERS SUPPORTING GIRDERS FOR PALACE OF HORTICULTURE

Design of 152-Foot Steel-Framed Dome

Determination of Loads and Stresses for Substructure, Consisting of Eight Piers, 65 Feet High, and Connecting Girders—Part II

By A. W. EARL and THOMAS F. CHACE
Assistant Engineers, Panama-Pacific International Exposition

THE 152-ft. diameter dome of the Palace of Horticulture for the Panama-Pacific Exposition at San Francisco, the superstructure of which was described in last week's issue, is supported on eight piers, 65 ft. in height. Each of these piers is composed of four columns placed at the corners of a quadrilateral. This quadrilateral (Fig. 11) has two sides normal to a radius of the dome passing through its center, the shorter side being 4 ft. 6 in. and two sides *A-B* and *C-D*, 15 ft. 10 in. in length and diverging at an angle of 45 deg. The bracing in the parallel sides *B-C* and *D-A* extends from the top of the piers to the bottom, but on the diverging sides, in order to provide a passageway, it had to be discontinued at 14 ft. 7 in. from the bottom.

COLUMNS

Between the tops of the interior columns of adjacent piers are plate-girders 6 ft. 4½ in. in depth, 57 ft. 5⅞ in. long. These, with the aid of trusses which frame from girder to girder across the interior faces of the piers, support the twenty-four ribs of the dome.

Between the exterior columns of adjacent piers steel trusses support a portion of the flat roof and the staff ornaments forming the decoration of the wall surrounding the lower part of the dome. Both the plate-girders and the trusses have knee-braces to the columns of the piers. The interior columns of the piers are 20 in., 59-lb. I-beams and are laced front and back with 5 x 3 x 5/16-in. angles. This lacing is single below the knee-braces and double above to provide for portal action. The columns are reinforced by plates where the lacing is discontinued between the interior and exterior columns. The interior columns are also reinforced at points of maximum bending. The girders supporting the dome ribs are 6 ft. 4½ in. out to out; the web is 5/16 in. thick and each flange consists of two angles 6 x 6 x 7/16 in. with one cover-plate 14 x ⅜ in. x 28 ft. Further particulars as to the make up of trusses and bracing are shown in the above photograph. The plate-girders and trusses between the exterior columns are braced together in the planes of their upper and lower chords. This not only serves the purpose of bracing the compression chords, but forms a stiff ring around the entire base of the dome, which effectually distributes the horizontal wind load to all piers.

DESIGN OF SUBSTRUCTURE

In figuring the wind load for the design of the dome the wind pressure was assumed at 20 lb. per square foot of vertical projection, which amounts to slightly more than 30 lb. per square foot, reduced 40 per cent for a cylindrical surface. In the design of the substructure, however, it was considered improbable that a wind pressure of 20 lb. would exist over the entire area of dome surface at one time. It was, therefore, thought consistent in the following computation to reduce the wind pressure on the smooth surface of the dome by multiplying by the factor 0.6 twice, once because of the circular horizontal section and again because of the circular vertical section. The resulting pressure = 30 × 0.6 × 0.6 = 10.8 lb. per square foot of projected area. The lower part of the dome and the lantern were loaded with 20 lb. per square foot of projected area since the ornamentation forms pockets for the wind.

The total horizontal load on the substructure was found to be as follows: Wind on lantern, 17,500 lb.; wind on dome to spring line, 100,000 lb.; wind on dome below spring line, 75,000 lb.; wind on remainder of structure to the flat roof of building, 120,000 lb.; total horizontal load, 312,500 lb.

An increase of 25 per cent was allowed for wind stresses over those allowed for dead load stresses, and, therefore, the equivalent horizontal dead load = 312,500 × 0.80 = 250,000 lb.

Two assumptions were made as to the distribution of this horizontal load among the piers. First, that the piers were loaded in proportion to their respective rigidities; and second, that they receive equal loads. The most unfavorable conditions given by the two assumptions were used in the design. In calculating the stresses in the two non-parallel sides, *C-D* and *A-B*, Fig. 11, it was considered that each pier acted independently as a cantilever, but in calculating the stresses in the knee-braces and the two parallel sides it was considered that each pier acted as part of a rigid structure with its neutral axis passing through the center of the octagon formed by the eight piers. The reason for this is apparent since the knee-braces are not very effective when they become normal or nearly normal to the direction of the wind.

FIRST ASSUMPTION

The assumption that the piers take their loads in proportion to their varying rigidities may be more precisely stated as follows: The horizontal load at the top of each pier will be to the total horizontal load as the moment of inertia of each pier about an axis through its center of gravity, normal to the direction of the wind, is to the sum of the moments of inertia of all eight piers about similar axes.

It was found by trial that the direction of the wind giving maximum stresses was, as indicated by the arrow in Fig. 12, parallel to the long diameter of the octagon formed by the eight piers. It was also found by trial that 18-in., 48.5-lb. I-beams answered the requirements for the outer columns and 20-in., 59-lb. I-beams for the inner columns.

In calculating the moments of inertia of the piers about axes normal to the wind the following well-known formula was used: If *x-x* and *y-y* be axes at right angles to each other and *y-y* be an axis of symmetry, then the moment of inertia about an axis *u-u* making an angle α with axis *y-y* may be expressed:

$$I_u = I_x \cos^2 \alpha + I_y \sin^2 \alpha$$

Referring again to Fig. 11 the axis *x-x* is distant from the center line of the 20-in. I-beams $(59 \times 0.83 + 48.5 \times 15.46 - 0.83) \div (59 + 48.5) =$ **6.60 ft.**

In calculating the moment of inertia of the pier about the *x-x* axis, Fig. 11:

The moment of two 18-in. I-beams about an axis parallel to *x-x* $= 2(798.3 \cos^2 22° 30' + 36.2 \sin^2 22° 30') = 1370$. The moment for the same beams about the *x-x* axis $= 28.50 \times 8.02^2 \times 144 = 264{,}000$. The moment of two 20-in. I-beams about their

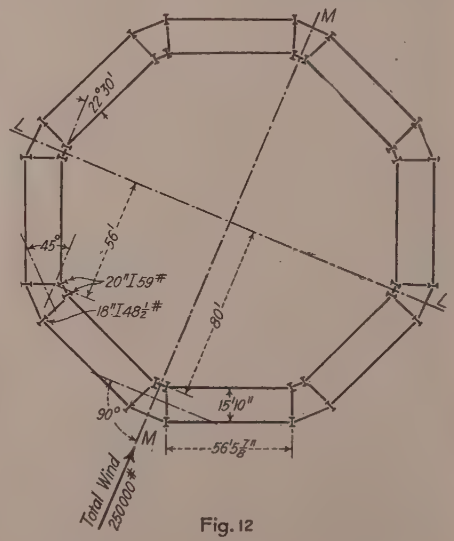


Fig. 12

ARRANGEMENT OF PIERS AND GIRDERS

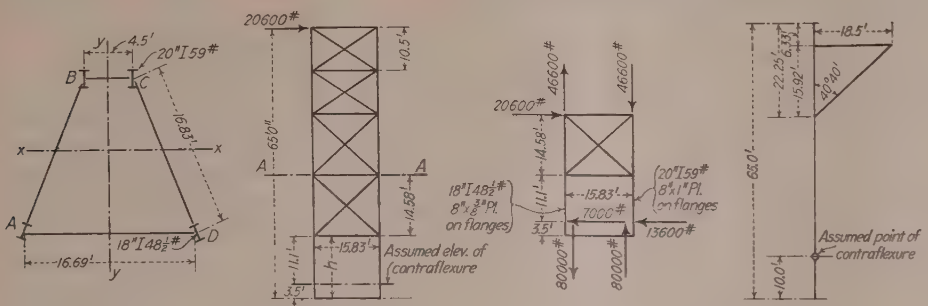


Fig. 11 Fig. 13 Fig. 14 Fig. 15

FIGS. 11-15—DETAIL OF PIER AND DIAGRAMS FOR STRESS COMPUTATION IN COLUMNS

own axis = 2344. The moment about the x-x axis $= 34.72 \times 6.60^2 \times 144 = 218,000$. The total = 485,914.

In calculating the moment of inertia of the pier about the y-y axis:

The moment of two 18-in. I-beams about an axis parallel to y-y $= 2(798.3 \cos^2 67° 30' + 36.2 \sin^2 67° 30') = 298$. The moment about the axis y-y $= 28.50 \times 8.34^2 \times 144 = 286,000$. The moment of two 20-in. I-beams about their own axis = 97. The moment about the y-y axis $= 34.72 \times 2.25^2 \times 144 = 25,300$. The total = 311,695.

The moment of inertia of the pier about an axis at 45 deg. with y-y $= 311,695 \cos^2 45° + 485,914 \sin^2 45° = 398,804$. Since there are two piers with axis x-x at 90 deg., four with axis x-x at 45 deg. and two with axis x-x at 180 deg. with the direction of the wind, as shown in Fig. 12, we have the following for the sum of the moments of inertia of the eight piers about axes normal to the wind: Two piers with x-x at 90 deg. to the wind $= 485,914 \times 2 = 971,828$; four piers with x-x at 45 deg. to the wind $= 398,804 \times 4 = 1,595,215$; two piers with axis x-x at 180 deg. to the wind $= 311,695 \times 2 = 623,390$; summation = 3,190,434.

Therefore, the horizontal loads at the tops of the various piers under the assumption are:

(1) On pier with axis x-x at 90 deg. $= (250,000/3,190,434 \times 485,914 = 38,000$ lb.; (2) on pier with axis x-x at 45 deg. $= (250,000/3,190,434) \times 398,804 = 31,300$ lb.; (3) on pier with axis x-x at 180 deg. $= (250,000/3,190,434) \times 311,695 = 24,400$ lb.

These loads are parallel to the direction of wind, but in order to apply them in computing stresses they must be resolved into their components parallel to the principal axes L and M, Fig. 12. In Table 1 the results of this simple resolution are recorded:

TABLE 1—LOADS PARALLEL TO PRINCIPAL AXES OF PIERS—WIND AS IN FIG. 12

Axis	Pier (1)	Pier (2)	Pier (3)
L-L	0	22,100	24,400
M-M	38,000	22,100	0

The governing loads then are 24,400 lb. parallel to axis L and 38,000 lb. parallel to axis M.

SECOND ASSUMPTION

Assuming that the piers are of equal rigidity and that all take equal loads, the load at the top of each pier in the direction of the wind = 250,000/8 = 31,300 lb. Resolving this load into its two components parallel to L and M Table 2 is had.

TABLE 2.—LOADS PARALLEL TO PRINCIPAL AXES OF PIERS—PIERS TO TAKE EQUAL LOADS

Axis	Pier (1)	Pier (2)	Pier (3)
L-L	0	22,100	31,300
M-M	31,300	22,100	0

The governing load under this assumption is 31,300 lb. parallel to either axis.

Combining the two assumptions we obtain, as designing loads, 31,300 lb. parallel to L, and 38,000 lb. parallel to M.

Calculating first the stresses in system A-B Fig. 11: The load applied at the top is (38,000/2) sec. 22° 30′ = 20,600 lb. This system may be considered as a vertical cantilever down to section A-A, Fig. 13. Below A-A it must be considered as a portal.

The stress in each strut above section A-A will be 20,600 lb. The maximum stress in the diagonals = 20,600 sec. 43° 10′ = 28,200 lb.

Below the section A-A it was assumed that the columns would take their horizontal loads in proportion to their rigidities. The sections finally obtained at the bottom of the portal frame, the plane of maximum bending, are as follows: For column A (Fig. 11), one 20-in. 59-lb. I-beam with 8 x 1-in. plate on each flange; for column B, one 18-in., 48.5-lb. I-beam with 8 x ⅜-in. plate on each flange.

Then (Fig. 11) in determining the moment of inertia of column A about axis parallel to x-x:

Moment for 20-in. I-beam about own axis parallel to x-x = 1172; moment for two plates about own axis = (1 x 8)/12 = 1, and moment for two plates about axis of I-beam = 1763; or total moment = 2937.

In determining moment of inertia of column A about axis parallel to y-y:

Moment for 20-in. I-beam about own axis parallel to y-y = 48; moment for two plates 8 x 1 in. $= (8)^3 \times 1/12 = 85$; and total moment = 133.

The moment of inertia of column A about axis normal to A-B $= 2937 \cos^2 30' + 133 \sin^2 22°30' = 2525$.

In determining the moment of inertia of column B about axis normal to A-B: The moment of the 18-in. I-beam about own axis = 798; moment of two 8 x ⅜-in. plates about axis of I-beam $= 6 \times 9.187^2 = 506$; total moment = 1304.

The horizontal reaction on column A $= (20,600 \times 2525)/(2525 + 1304) = 13,600$ lb. The horizontal reaction on column B $= (20,600 \times 1304)/(2525 + 1304) = 7000$ lb.

It was considered that the columns would be partially fixed and the plane of contraflexure was assumed at 3.5 ft. from the bottom which is approximately one-quarter of h, Fig. 13. Then the vertical reaction at the top of the portal frame $= 20,600 \times 35.84/15.83 = 46,600$ lb.; and at the plane of contraflexure $= 20,600 \times 61.50/15.83 = 80,000$ lb; and the horizontal load (Fig. 14) at the top of the portal = 20,600 lb. The tension in diagonal a-b (80,000 — 46,600) sec 47° 21′ = 49,300 lb. Compression in upper strut $= 13,600 \times 11.1 \times 20,600/14.58 = 31,000$ lb. Compression in lower strut $= 13,600 \times 25.68/14.58 = 24,000$ lb.

STRESS IN COLUMN A

The dead load on the sixteen inside columns = 1,765,700 lb. or the dead load on one column = 110,000 lb. The compression on the column due to overturning = 80,000 lb. The uplift due to one and one-half dome ribs on the basis of 20 lb. per square foot of projected area $= 13,000 \times 1.5 = 19,500 \times 0.6 \times 0.8 = 9300$ lb. The maximum bending in column $A = 13,600 \times 11.1 \times 12 = 1,810,000$ lb. The distance of the extreme fiber of the column from its neutral axis $= 11.0 \cos 22° 30' + 4 \sin 22° 30' = 11.70$ in. Therefore, the summation of the stress in the column is: fiber stress $= 1,810,000 \times 11.70/2525 = 8400$ lb. per square inch; dead load stress = 110,000/33.36 = 3300 lb. per square inch; wind load stress = (80,000 — 9300)/33.36 = 2100 lb. per square inch; and the total stress = 13,800 lb. per square inch. Since this maximum stress occurs at the point where the column is supported by the lower strut of the portal it is well inside safe limits.

STRESS IN COLUMN B

The dead load on sixteen outside columns = 344,000 lb. or the dead load on one column = 21,500 lb. The compression due to the overturning of the pier = 80,000 lb. and the maximum bending at the bottom of the portal frame $= 7000 \times 11.1 \times 12 = 930,000$ lb. per square inch. The distance from the neutral axis to the extreme fiber = 9.375 in. The total stress on the column is then as follows: fiber stress $= 930,000 \times 9.375/1304 = 6700$ lb. per square inch; dead load stress = 21,500/20.25 = 1060 lb. per square inch; wind load stress = 80,000/20.25 = 3950 lb. per square inch; and the total stress = 11,710 lb. per square inch. This occurs at a point of support and is well on the side of safety.

The following arbitrary assumptions were made in determining stresses in the sides of the pier parallel to x-x, Fig. 11: First, that 75 per cent of the total load of 31,300 lb. is taken by the bracing between the inside columns A and D and 25 per cent by bracing between the outside columns C and B. Second, that there would be sufficient fixing effect at the bases of the pier to cause contraflexure 10 ft. from the bottom of the piers when the structure is considered as a rigid whole, tending to overturn about an axis through the centers of the bases of two opposite piers.

OVERTURNING MOMENT

The total moment tending to overturning the structure was found to be 26,525,000 ft.-lb. The vertical reactions on the piers caused by this overturning were considered as acting on the large interior columns. Let V_1, V_2 and V_3 represent the reactions at the foot of the pairs of columns at distances of 0 ft., 56 ft. and 80 ft. respectively from the neutral axis of the dome. Then if a is the reaction on a pair of columns at a unit distance we have $V_1 = 0$, $V_2 = 56a$ and $V_3 = 80a$. Then $4 \times 56^2a + 2 \times 80^2a = 26,525,000$; hence $a = 1050$ lb. $V_1 = 0$, $V_2 = 1050 \times 56 = 58,800$ lb. and $V_3 = 84,000$ lb.

The corresponding horizontal reactions are as follows: $H_1 = 31,300 \times 0.75$

$= 23{,}500$ lb.; $H_2 = 22{,}100 \times 0.75 = 16{,}600$ lb., $H_3 = 0$.

This section required at the foot of the knee-braces was found to be two 20-in. 59-lb. I-beams spaced 4 ft. 6 in. on centers with one 16 × ⅜-in. plate on the outside of each web. The section modulus of this section = 1112 in.^{3}

The fiber stresses due to bending in each of the piers (Fig. 15) are as follows:

$K_1 = 23{,}500 \times 32.75 \times 12/1112 = 8300$ lb.; $K_2 = 16{,}600 \times 32.75 \times 12/1112 = 5900$ lb.; $K_3 = 0$.

The dead load stress in each column = 110,000/23.36 = 4700 lb. per square inch.

The direct stress due to overturning for each column is as follows: $P_1 = 0$; $P_2 = 58{,}800/2 \times 23.36 = 1260$ lb. per square inch; $P_3 = 84{,}000/2 \times 23.36 = 1800$ lb. per square inch.

The maximum total stress in the column then is found to be in the pier at the neutral axis and is summed up: Dead load stress, $P = 4700$; vertical stress due to overturning, $P_1 = 0$; bending, $K_1 = 8300$; total = 13,000 lb. per square inch.

The latticing between the 20-in. I-beams was designed for a shear below the knee-brace of 23,500 lb. and above the knee-brace of 23,500 × 32.75/15.92 = 48,000 lb. The stress in the knee-brace was found to be 23,500 + 48,000/2 × cos 40° 40′ × cos 22° 30′ = 51,000 lb.

The bracing between the 18-in. I-beams was designed for a shear below the knee-brace of 31,500 × 0.25 = 7850 lb. and above the knee-brace of 7850 × 32.75/15.92 = 16,000 lb. The stress in the outside knee-brace was found to be 7850 + 16,000/2 × cos 40° 40′ × cos 22° 30′ = 17,000 lb.

ERECTION

The steel of the substructure rests upon a timber grillage, supported by piles. These timber caps are well drift-bolted to the caps. This is counted on as producing some fixing effect upon the columns.

The substructure was completely erected before any of the dome ribs were placed. For raising the ribs of the dome a battered tower was constructed in the center of the dome area, slightly greater in height than the tops of the plate girder. Upon this tower was placed one guyed mast and two guyed derricks. The mast supported the top ring of the dome by means of rod hangers with turnbuckles. By means of the turnbuckles in these hangers and in the guys adjustment of the position of the top ring was made.

The portion of the ribs between the girders and the first splice, including the rings and diagonal rods, were erected first. Meanwhile the remaining ribs were assembled in pairs on the ground; a pair of ribs with these connecting rings and diagonal rods were riveted together, and swung into place by the guyed derrick, completing the erection of the steel. The weight of such a pair of ribs complete was approximately 8 tons. All field connections of the dome were riveted. In the substructure, however, the field connections were bolted, using ordinary bolts.

The weight of steel for that portion of the structure above the top of the plate girders is 200 tons. This amounts to 8½ lb. per superficial square foot of roof surface or 0.304 lb. per cubic foot of volume of the portion considered. The total weight of steel in the dome and substructure is 503 tons, giving an average weight of 0.358 lb. per cubic foot of volume enclosed by the frame. The corresponding quantities for the horticultural building at the Chicago Exposition were: Steel per superficial square foot, 10.7 lb.; steel per cubic foot, 0.312 lb.

The plans were prepared by the Division of Works of the Exposition Company, of which H. D. H. Connick is director of works and A. H. Markwart, assistant director of works. The dome and substructure were designed by the writers under the immediate supervision of H. D. Dewell, chief structural engineer. After the design was complete, the stresses in the dome were checked by Richard G. Doerfling, civil engineer. Bakewell & Brown, of San Francisco, were the architects of the building. Dyer Brothers, of San Francisco, were the contractors for the fabrication and the erection of the steelwork.

Philadelphia Association Opposes General Measures for Licensing Engineers

Advocates Instead Laws Requiring Approval by State of Designs for and Construction of Engineering Structures

As noted on page 450 of the last issue of the Engineering Record, a Pennsylvania commission is investigating the advisability of licensing engineers. The subject was discussed by the Philadelphia Association of members of the American Society of Civil Engineers at a recent meeting, and a committee was appointed to draw up a report giving the views of the association. The report, opposing not only the bill offered for discussion by the commission but also any general licensing measure, was presented to the commission at a hearing in Philadelphia Oct. 19, and is reprinted here in full, except for one section, as indicated. The committee was composed of Edgar Marburg, professor of civil engineering, University of Pennsylvania, chairman; John Sterling Deans, chief engineer, Phoenix Bridge Company; Richard L. Humphrey, consulting engineer; John W. Ledoux, chief engineer, American Pipe and Construction Company; H. R. Leonard, engineer of bridges and buildings, Pennsylvania Railroad; Henry H. Quimby, chief engineer, Department of City Transit, Philadelphia; S. M. Swaab, civil engineer, Keystone State Construction Company; Edward B. Temple, assistant chief engineer, Pennsylvania Railroad; Samuel Tobias Wagner, assistant engineer, Philadelphia & Reading Railway.

The report is as follows:

The committee desires, first, to present certain general considerations, and then to treat the subject under the following headings:

A. Objections to any plan looking to the licensing of engineers in the State of Pennsylvania.

B. Specific objections to the terms of the particular act proposed by the Engineers' Commission.

C. A proposed plan for accomplishing the avowed purposes of this act in a more direct and effective manner.

GENERAL CONSIDERATIONS

1. In support of plans for licensing engineers in a given state, the claim is usually made that there is the same need of licensing engineers as of licensing lawyers and physicians, whereas the conditions in engineering are, in fact, wholly different from those in law and medicine. In the latter professions the public interests cannot be measurably protected against charlatans and quacks except through licensing on the basis of individual examinations, although experience has shown that even that safeguard is inadequate for the purpose stated. It may, in fact, be confidently affirmed that no plan of licensing can serve to eliminate unscrupulous, though technically competent men, who will not hesitate to resort to unprofessional practices in so far as that may be possible with safety to themselves.

In engineering, unlike law and medicine, the public may be protected against incompetent or unscrupulous practice, not by the licensing of engineers, but by State approval of plans before execution, by State inspection during construction, and by other means to be set forth in more detail.

2. The fact that the licensing of lawyers and physicians is required in every State of the Union, whereas provision for the licensing of engineers is made in only two States (Louisiana and Wyoming) indicates that the fundamental differences, from the standpoint of public interests, between the professions of law and medicine on the one hand and that of engineering on the other, are widely recognized. The burden of proof in justification of an act designed to license engineers in the State of Pennsylvania rests, therefore, upon the sponsors of such an act.

3. In support of a plan for licensing professional engineers it may be claimed that it is necessary for the promotion of safety and the protection of life, health and property. It will be shown, however, that these ends cannot be attained through such an act, and that other measures would be far more effective towards their accomplishment.

A. OBJECTIONS TO ANY PLAN OF LICENSING

1. The licensing of independently established consulting engineers is objectionable on the following grounds:

(a) That the plan would afford no reliable guarantee that those who pass prescribed examinations will not design unsafe work through incompetency, carelessness, or under pressure of economical restrictions.

(b) It is a well-known fact that the test of examination becomes increasingly inadequate as the value to be set upon experience, and sound judgment based on such experience becomes increasingly important. It is easy, for example, to determine by examination a candidate's qualifications for such minor positions as rodman, draftsman, etc., but difficult to ascertain by such a test a candidate's fitness for an engineering position involving large and varied responsibilities. It is impossible to carry in one's head the many data which a seasoned engineer would readily command in his normal office environment, where he has access to reference books, filing cases, personal notes, etc., which would readily enable him to find the desired data; whereas such accessories would be of comparatively little value to an inexperienced man. On the other hand, it is easily conceivable that the latter would outstrip the seasoned man in an examination, since it is almost impossible, in an examination, to set the proper value upon ability and experience as distinguished from mere book knowledge.

Specialization Would Be Necessary in Examinations

(c) The field of engineering is so highly specialized, and the various specialties overlap to such a degree, that no individual can reasonably be expected to qualify in a full sense in more than a single specialty and, in a modified sense, in closely related specialties. The term "professional engineer" is therefore meaningless, except in an inclusive way as covering many specialized titles. Such a specialty as railroad engineering, for example, is properly subclassified under design, construction, maintenance and operation. A given individual may deservedly have attained to the highest rank in construction, although he may command little or no knowledge of designing. A fair examination in such a case should be limited to construction; or better still, the personal record of the individual concerned should be accepted as a far better criterion of his qualifications than any form of examination.

(d) That the licensing of engineers will not serve to avert disaster through improper design or construction is attested by the calamitous failures that have at times attended engineering operations under the direction of engineers deservedly recognized as among the ablest members of the profession—men who would unquestionably have qualified under a proper examination.

Licensing of Salaried Engineers

2. The licensing of salaried engineers, as distinguished from independent consulting engineers, is objectionable on the following grounds:

(a) The great majority of engineers (probably not less than 90 per cent) hold salaried positions, and the legal and moral responsibility for their professional work should fall on the employing municipalities, corporations or firms by whom their competency can also be far better determined than through the operation of any legislative act. The licensing of such engineers would therefore serve no useful purpose, and would be an unnecessary source of expense and annoyance to those affected.

(b) No scheme of examination that can be devised is as effective for determining the degrees of professional competency as the principles ordinarily governing the employment, promotion and discharge of salaried men.

(c) Every salaried engineer upon merited promotion to a position of a certain higher responsibility would have to pass an examination prescribed by the State. His rejection upon such an examination would work an undeserved professional injury to the individual concerned, and would justly tend to bring ridicule upon the examining system.

(d) In the promotion of engineers to positions of higher responsibility by corporations whose activities extend beyond the State, such as railroad companies, public service corporations, etc., the transfer of an individual from another State to Pennsylvania could not take place without subjecting him to an examination involving the contingencies just mentioned.

B. Objections to Proposed Act

[The greater part of this section of the report, dealing with detailed criticism of the proposed bill, has been omitted.—Editor.]

The proposed act is incomplete in failing to provide for certain important features, as, for example, the following:

(a) The professional complexion of the examining board. Modern engineering is so highly specialized that it may be confidently affirmed, too, that an examining board consisting of only nine members, no matter how otherwise constituted, would be incompetent to supervise examinations in every important engineering specialty.

(b) Since no individual can possibly qualify as a "Professional Engineer" in the inclusive sense, the act should indicate by title, and define as to scope, the various divisions of professional engineering in which candidates may qualify by examination. The difficulty of doing this is manifest, and this only serves to indicate the futility of determining the competency of engineers for high professional services through examination.

(c) The progress in engineering, especially in certain lines, is so rapid that an engineer who may readily pass a fair examination at a given period, may be utterly unable to qualify under an up-to-date examination five or ten years later, unless he has kept well abreast of progress. Therefore, if examinations are to be applied as a test of competency, they should be reapplied at suitable intervals, as is the practice, for example, in the United States Army and Navy.

(d) It should be explicitly stated in the act that the engagement of a professional engineer will not serve to absolve the employer of such an engineer from legal responsibility for his acts and their consequences; that is to say, that it will not shift such legal responsibility either upon the professional engineer or upon the State.

The terms of the act fail to make adequate provision for its application, in that an examining board of nine members, assisted by one secretary and one stenographer, cannot possibly meet the practical requirements entailed.

The proposed terms of the act are objectionable in that the members of the examining board "shall serve without compensation" and shall only be allowed "expenses actually and necessarily incurred in the performance of their duties." * * * It is both undignified and unfair for a great state to expect individuals to render professional services of such a high grade and such great volume at their personal sacrifice. * * * The conduct of examinations in law and medicine is a comparatively simple matter. In engineering, on the other hand, examinations designed to accomplish the expressed purposes of this act would have to be of a specialized kind and of advanced grade to test the fitness of the candidates for high responsibilities.

C. Proposed Plan for Accomplishing Avowed Purpose of Act

Assuming that the proposed act is designed solely as a protection to public interests, as stated in its title, and is not designed to elevate professional standards or to promote the pecuniary interests of the members of the engineering profession, its purpose may be accomplished much more directly and effectively through legislation to the following ends:

(a) To create a State engineering department, board or commission by which engineering designs may involve public safety would have to be approved before execution. This department, board or commission should also be charged with the inspection of engineering works during construction, at such intervals and to such extent as may be deemed proper.

(b) To exempt from the supervision of this department, board or commission work designed and constructed by municipalities and approved corporations, such as railroad companies, etc., which are not only legally responsible for, but have an immediate and lasting interest in engineering operations conducted on their behalf and under their supervision.

(c) To require the licensing of county surveyors and other surveyors in independent practise. Fair examinations for surveyors can easily be set, which would serve to exclude incompetent men whose incompetency would be likely to entail property losses and expensive litigation.

(d) To license other classes of technical men whose duties are of a definite and restricted nature in fields where incompetency would be attended by results similar to those just mentioned in connection with surveyors, and in which competency may readily be determined by examinations.

Conclusion

Summarizing, it may be said:

1. That laws under which engineering designs must be officially approved before their execution are in satisfactory operation in certain European countries.
2. That such laws tend to deter incompetent engineers from preparing designs without competent assistants.
3. That the act under review is inadequate as a measure of protection to public interests.
4. That this act is objectionable in that it will license as "Professional Engineers" men who, neither by experience nor professional attainments, can safely be entrusted with the responsible designing of engineering works. The fact that they have been licensed will tend to invite confidence in their competency on the part of the public to a degree which they would otherwise not command.
5. That in so far as this act may tend to delay the enactment of statutes of the kind here proposed, its effect would be directly hurtful to public interests.

Ash Handling by Vacuum Conveyor in the Turkey Creek pumping station in Kansas City cost $6.40 per day less than by the former hand removal according to the last annual report of the Water Department. The plant, installed by the Green Engineering Company, removes ashes from the ash pits in the basement to a tank from which they feed by gravity into railway cars. The railroad pays $6 per car for the ashes. The guaranteed capacity of 250 lb. per minute was exceeded in test by 20 lb. Two men remove all ashes, load cars, clean the machine and take general care of the boiler-room basement. Costs of operation during 178 days were $712 for labor and $37.19 for repairs. Against this are receipts for $186 for 31 cars sold, a figure balanced by the estimated cost of power for running the machinery three and one-half hours per day. By the old method five men and a mule would have cost $1,886.80.

Dustless Granite Block Pavement at Lawrence

Clearance of $\frac{3}{16}$ Inch on All Four Sides of Block Grouted with 1:1 Cement and Sand Mixture—Surplus Grout Removed

WITHIN the past 3 yr. about 10 mi. of grouted granite block pavement laid upon a sand base have been installed at Lawrence, Mass., and the results of its use have been so satisfactory that from fifteen to twenty carloads of blocks are being received daily by the city for this class of highway construction. At an initial cost of about $3 per square yard a street surface of substantially permanent character is provided, the maintenance charges on this construction being practically nil. The surface obtained is dustless, wears but little under the heaviest traffic, and while fairly smooth is still sufficiently uneven to furnish a footing for horses even in unfavorable weather. The principal trunk highways entering and leaving the city, as well as a number of side streets, have been built in this way, and general application of this method of construction is being made by the city.

The first use of granite block paving with cement grouting on a sand base was on Park Street, Lawrence, 12 yr. ago and today the surface of this roadway, which is a downtown lateral thoroughfare, shows little evidence of its long service. The street resembles an asphalt pavement in appearance, and only on close inspection can the blocks be seen. On Merrimac Street a section 1 mi. long has been paved in this way with second-hand blocks 35 yr. old taken from Broadway and Essex Street. In the first year of its service it has not been necessary to expend a cent in maintenance and no sign of cracking has appeared, even at the edges of the roadway. Paving with new blocks has lately been completed on Broadway from the Andover to the Methuen town line, as well as on east and west streets leading toward Haverhill and Lowell. The Massachusetts Highway Commission has requested the city authorities to pave a section of Jackson Street comprising a part of a state highway in this manner. The work is all done by day labor under the direction of Paul Hannagan, commissioner of engineering and acting mayor, who has applied for a patent on this method of road construction.

The features upon which a patent claim is made are the use of a squeegee for the removal of the excess grout from the surface and a subsequent smoothing operation involving the application of water by means of a brush.

Straight Edged Blocks

The blocks used are the so-called standard Boston block and are purchased direct from New England quarries, ready for laying. These must be at least 8 in. deep, from 3½ to 4½ in. wide, and from 10 to 13 in. long, with sharp and straight edges, forming right angles at intersections both horizontal and vertical. The faces are straight split and are required to be free from bunches or depressions; but the presence of voids is considered advantageous since they key the cement grout and greatly increase the rigidity of the pavement. The blocks are not dressed by the city.

In laying this pavement the roadway is excavated to a smooth surface to a depth of 9½ in. below the surface of the completed pavement. It is then rolled, and a sand cushion 2 to 3 in. deep is applied, the sand being useful mainly in laying the blocks to line and enabling the builder to compensate for varying heights in the blocks. The blocks are then laid by hand, generally in parallel courses at right angles to the street axis. The longitudinal joints are broken by a minimum lap of 2 in., sufficient sand being used under the blocks to bring them to the grade and form of the finished roadway after ramming. Blocks are laid with a clearance of 3/16 in. on all four sides. The blocks are stiffened with a sprinkling in the joints of clean pea gravel used very sparingly and are then rammed and wet down for the reception of the grout. The latter is composed of half-and-half Portland cement and sand, mixed on the street in inclined steel boxes carried on rollers, each box holding 1½ bags of sand and 1½ bags of cement, with a sliding gate at one end, handles and a mounting of 12 in. above the ground. Enough water is added to make a thin grout and extreme care is taken to mix the ingredients thoroughly.

GROUTING GRANITE BLOCK PAVEMENT AT LAWRENCE

Surplus Grout Removed

The wet pavement is covered about ½ in. deep to allow for shrinking, but before the initial set begins, all surplus cement is removed from the surface with a rubber squeegee, hoe or trowel and returned to the mixing box for further use. Shortly after removing the surplus cement and before the grout is set the pavement is smoothed by water applied with a kalsomine or other smooth brush, brushing across the joints and leaving no cement on the paving. For ten days the street is kept closed and wet as often as needed to keep the pavement from being dry for any length of time. The resulting surface, while smooth to the eye, preserves the roughness of the blocks, prevents skidding of automobiles and allows no dust to arise from the grinding of the cement surface that otherwise would be left on the roadway. One paver can lay about 50 sq. yd. of blocks in 8 hr. A crown of 5 to 6 in. is generally used, and the streets are paved up to the curbs, no flagstones being employed at crossings.

On steep grades where street railway tracks are located, the city now provides special paving inside rails, and leaves a ½-in. to a ⅝-in. groove between blocks to facilitate the handling of vehicular traffic without slippage. These grooves are formed by sweeping sand over the blocks after the cement has had about 15 min. in which to set following its pouring from the mixing box. Outside the tracks the roadway is left smooth with the usual paving as described above. The city also does the paving between street railway tracks on level thoroughfares.

Water Jet Used to Lift Stone at Concrete Plant

STONE for the concrete lining of Arthur's Pass tunnel in New Zealand, as stated in the article on this work in the issue of Oct. 17, page 438, is obtained largely from the banks of a river nearby. All stones above 8 in. in diameter are rejected. The balance are sluiced into a 16-in. flume on a 4 per cent grade and thus carried to the intake of a 9-in. "blow-up" or hydraulic elevator. This elevator is operated by water under a 400-ft. head delivered from a 5-in. pipe through a 1⅝-in. nozzle, and raises water and shingle 35 ft. into an elevated flume 24 x 8-in. on a 3 per cent grade, so placed as to command the lower bins, crushers and storage piles. There are two fixed gratings in this flume. The first rejects large stones and passes them back to a crusher delivering back again into the intake of the hydraulic elevator. The second rejects all material above 1½ in., which has passed through the first screen. This falls to a crusher which delivers into the boot of a bucket elevator of 50-ft. lift. The elevator discharges into a swinging arm chute covering the whole of the bin commanding the mixers and cars at formation level. The shingle and sand not rejected by the gratings in the flume are discharged at will into the lower bins or storage pile. The lower bins deliver into the above-mentioned boot of the 50-ft. bucket elevator.

Concrete Highways, 16 ft. in width and totaling 10 mi. in length, have been laid in the state of Oregon during the season of 1914. A total of about 4 mi. of 8-ft. concrete pavement was also laid. Next year it is planned to lay 15 or 20 mi. of 8-ft. concrete pavement, besides the amount of 16-ft. pavement for which funds are found to be available.

Effect of Steaming Process of Creosoting on Strength of Oregon Fir Piling

Comparative Tests on Treated and Untreated Piles to Determine to What Extent This Method of Treatment Alters the Physical Properties

TESTS to determine the effect of the steaming process of creosoting, as practised at a plant on the Pacific Coast, show that the strength of Oregon fir piling is materially decreased thereby. The tests were conducted under the direction of H. B. MacFarland, engineer of tests, and G. E. Rex, manager of treating plants, of the Atchison, Topeka & Santa Fé Railway, and are discussed by Mr. MacFarland in the August "Bulletin" of the American Railway Engineering Association. These notes are taken from his discussion.

TEST PIECES

To get the maximum penetration desired special test lots were run. The material was selected from regular stock at the treating plant, and was considered representative timber as to density of grain, sapwood, knots and conditions of creosoting. The sapwood, however, was deeper than that ordinarily found in average material. The logs, at time of treatment at this plant, have ordinarily been cut from three to six months. Just previous to treatment they are taken from salt water and the bark is removed.

Twenty logs, varying in diameter at the butt from 12 to 18 in., and in length from 40 to 60 ft., were selected for test. From each log two specimens, each 15 ft. long, were cut for test purposes. Ten of the forty specimens were given the regular 18-hr. treatment and ten were given an extra heavy 26-hr. treatment to permit heavier and deeper penetration. In order to get the best comparative figures as to the effect of creosoting on the different parts of the log, alternate butts and tops were treated.

THE STEAMING PROCESS

The material is subjected to three processes under the steam-creosoting method, namely, steaming, removing moisture and filling with creosote. When introduced into the treating tanks the logs are thoroughly wet, coming direct from the salt water. They are then brought to a temperature of about 330 deg. in a period of 1½ hr. by the introduction of steam. This temperature is maintained 1½ hr. A vacuum of about 28 in. is then produced, and the temperature is reduced to a minimum of 190 deg. The vacuum is maintained 10 hr., after which the tanks are filled with oil at 190 deg. temperature and an average pressure of 75 lb. is maintained 5 hr., or until the piles have taken up the proper quantity of oil. The oil is then drawn off from the tank, after which the timber is removed.

Transverse tests, compression tests parallel and perpendicular to the grain, and shearing tests were made, pieces for the compression and shearing tests being cut from the larger pieces for the transverse tests. The moisture content was determined for both the treated and the untreated test pieces, and the amount of creosote per cubic foot absorbed by the former was ascertained by weighing all specimens. In order to determine whether the wood in the interior not reached by the creosote was injured by the creosoting process minor specimens were taken from the hearts of treated and untreated major specimens.

PENETRATION

Study of the specimens showed clearly the effect of high temperature from pressure used in the steam creosoting process. The original defects in the timber were as a rule amplified; checks and cracks were enlarged, and in many cases the cohesion of annual growth rings was lessened to such an extent that separation of the rings in the form of a circular check took place, particularly where there were pitch rings.

It was observed, by examining under the microscope very thin sections of treated and untreated Oregon fir, that the sapwood consisted of small fibers of cellulose, approximately 0.0006 in. in diameter, separated by small ducts containing coagulated sap. Resins were entirely absent. The heartwood appeared to be a little different from the sapwood in size or fineness of fiber. The ducts contained resinified sap, and minute pockets of resin were easily discerned.

On examination of the cross-section of the wood the alternate soft and hard rings were easily seen. The soft rings consist of somewhat spongy material and are called "spring wood." The rings of spring wood are surrounded by rings of "summer wood," the latter being as a rule much narrower than the former. The summer wood, by reason of the greater vitality of the tree in summer than in spring, has a greater strength and density. Under the microscope it was observed that the summer wood had a well defined fibrous structure, indicating a certain measure of capillarity. The spring wood, however, was poorly organized; the fibers of cellulose were widely separated by ducts probably containing albumen, starch and cellulose.

HEARTWOOD NOT PENETRATED

In the treated specimens tested the treated areas were sharply defined. The untreated areas consisted of heartwood. The depth of penetration in 75 per cent of the treated specimens corresponded very closely to the depth of sapwood in the untreated specimens. The heartwood in Oregon fir is so refractory that it is almost impossible to bring about an absorption of creosote. At best only a slight degree of penetration can be obtained, even in perfectly seasoned material, without the use of great pressure and high temperature. The ends of the fibers in cross-sectional treatment are almost totally resistent to treatment. That portion of the cross-section containing sapwood undoubtedly takes up considerable treatment longitudinally. Wood containing checks, cracks, shakes, loose open fibers and other physical defects absorbs much creosote longitudinally by reason of the pressure used in the creosoting process, but there is practically no end penetration whatever in a perfectly sound specimen of Oregon fir.

Dark striations separated by margins of uncolored wood, coinciding with the rings of summer wood, extending for some distance into the wood, were observed. These striations were due to longitudinal absorption by summer wood of a very small amount of creosote. They often extended to considerable distances into the treated specimens. It is often seen in boring into a treated pile or bridge timber perpendicular to the grain that dark-colored fiber is nearly always found well outside the zone of active penetration. The alternate areas of treated and untreated material are easily seen by examination of the core extracted by an increment auger. The dark portions are due to longitudinal capillary absorption of creosote by summer growth rings. It is doubtful if the amount of treatment contained in the summer growth rings of heartwood is sufficient to resist the incursions of the teredo navalis.

TRANSVERSE TESTS

Sixty-five per cent of the treated specimens and 90 per cent of the untreated specimens failed in horizontal shear. That more untreated than treated specimens failed in this manner was due to the fact that the outer fiber in the untreated specimens was much stronger than in the treated. In the treated specimens, the outside fiber was weakened to such an extent by the creosoting process that in some cases failure occurred in tension before a stress sufficient to shear the specimens was reached. The failure in some specimens was influenced by knots and checks.

It has been found in tests on rectangular beams of treated and untreated Oregon fir that the common failure in treated specimens was by horizontal shear. In the untreated specimens, half failed by horizontal shear and half by tension. The greater frequency of horizontal shear failures in treated material of rectangular cross-section than that of circular cross-section is due to the different effects of vertical stress in transverse test on the rectangular and circular cross-section. In the rectangular cross-section the horizontal shear is of greater intensity than in a circular cross-section of the same area for the same loading.

In order to show the effect of treatment on the strength of Oregon fir piling Table 1 has been prepared. The rating is based on the modulus of elasticity of untreated specimens as 100 per cent. It is to be observed that the modulus of elasticity of treated specimens is 28 per cent less than that of the untreated specimens. The modulus of elasticity is, of course, influenced by knots, checks and other defects, which cause early failures. The minimum value, 990,000 lb. per square inch, was obtained from a specimen which not only had many defects, but appeared to have been injured by the creosoting process.

TABLE 1—MODULUS OF ELASTICITY—POUNDS PER SQUARE INCH

	Maximum	Minimum	General average	Rating per cent
Untreated ...	2,235,000	1,384,000	1,846,000	100
Treated	1,692,000	990,000	1,328,925	72

Table 2 shows the modulus of rupture for treated and untreated specimens, based on the modulus of rupture of untreated specimen as 100 per cent. It is to be

TABLE 2—MODULUS OF RUPTURE—POUNDS PER SQUARE INCH

	Moisture per cent	Maximum	Minimum	General average	Rating per cent
Untreated .	13.68	8,233	6,002	7,028	100
Treated ...	16.70	5,215	2,206	4,058	58

noted that the transverse strength of the treated specimens is only a little more than half as great as that of the untreated pieces. It is also seen that there is very wide divergence between the maximum and minimum moduli of rupture of treated specimens.

COMPRESSION AND SHEAR TESTS

Compression Parallel to the Grain.—Table 3 shows comparative results of compression tests parallel to the grain of treated and untreated material. It is seen that the treated material is 27 per cent weaker than the untreated, while in the transverse test the treated specimen is 42 per cent weaker. The effect of abnormal temperature and pressure is to bring about a greater loss in transverse than in compressive strength .

TABLE 3—COMPRESSION TEST PARALLEL TO GRAIN—POUNDS PER SQUARE INCH.

	Elastic limit	Maximum load	Modulus of elasticity	Rating per cent
Untreated	3,003	3,563	325,940	100
Treated	2,257	2,595	252,770	73

Compression Perpendicular to the Grain.—Table 4 summarizes the compression test perpendicular to the grain. The rating is based on the load in pounds per square inch for a deflection of ⅜ in. in untreated specimens as 100 per cent. It is seen that the loss in compressive strength of treated material is 32 per cent. This loss is due to the softening of the fiber by the steaming process. It was noted in making the compression tests perpendicular to the grain that the fiber appeared to be very elastic. After failure by crushing, the specimen returned almost to its original shape.

TABLE 4—COMPRESSION TEST PERPENDICULAR TO GRAIN—POUNDS PER SQUARE INCH

	Elastic limit	Load	Rating per cent
Untreated	664	1,007	100
Treated	313	687	68

Shear.—Table 5 gives the horizontal shearing strength in the transverse test and the shearing strength parallel to the grain. It is seen that the loss in horizontal shear in treated specimens is 48 per cent and in shear parallel to the grain, 30 per cent. Creosoting processes greatly diminish the cohesion of fibers in Oregon fir. The loss in shearing strength is a serious defect not only in bridge timbers, but also in piling. Treated bridge timbers usually fail by shearing rather than by tension. The method of driving piling causes severe sudden vertical stresses to be applied, and in case there is especial weakness in shearing strength, failure is brought about by the "shelling off" of annual growth rings under the blows of the pile driver.

TABLE 5—SHEARING STRENGTH—POUNDS PER SQUARE INCH

	Maximum	Minimum	General average	Rating per cent
Horizontal Shear				
Untreated	382	262	318	100
Treated	254	83	180	52
Shear Parallel to Grain				
Untreated	391	250	311	100
Treated	340	136	217	70

OTHER COMPARISONS

Butts and Tops. — The comparative strength of butts and tops of treated and untreated Oregon fir piling is shown in Table 6. It is seen that there is little difference in the strength of butts and tops of untreated specimens; but that the treated tops are considerably weaker than the treated butts. This is no doubt due to the fact that although the depth of sapwood is the same in untreated and treated timbers, the actual percentage of sapwood is greater in the tops than it is in the butts, due to smaller cross-sectional area. As a result the percentage of weakened fiber due to treatment in the top is greater than in the butts, causing lower stress per unit area to produce failure.

TABLE 6—COMPARATIVE STRENGTH OF BUTTS AND TOPS—POUNDS PER SQUARE INCH

	Transverse test		Compression test			
			Parallel to grain		Perpendicular to grain	
	Modulus of rupture	Rating per cent	Maximum load	Rating per cent	Load for ⅜-in. deflection	Rating per cent
Untreated						
Butts	6,827	100	3,586	100	1,020	100
Tops	7,229	106	3,539	99	995	98
Treated						
Butts	4,530	100	2,959	100	765	100
Tops	3,586	79	2,172	73	610	80

Eighteen-Hour and Twenty-Six-Hour Treatment.—In order to show the effect of length of time of steaming on the strength of the material, Table 7 has been prepared.

TABLE 7—COMPARATIVE STRENGTH AFTER 18-HOUR AND 26-HOUR TREATMENT—POUNDS PER SQUARE INCH

	Transverse test		Compression test			
			Parallel to grain		Perpendicular to grain	
	Modulus of rupture	Rating per cent	Maximum load	Rating per cent	Load for ⅜-in. deflection	Rating per cent
18-Hour	2,722	100	2,705	100	715	100
26-Hour	2,405	88	2,486	92	660	92

The results indicate that the 26-hr. treatment is more detrimental to the strength of the material than the 18-hr. treatment.

Minor Specimens.—Comparative results for the major and minor specimens are shown in Table 8. It is seen that the treated minor specimens show considerable loss in strength as compared with the untreated specimens.

TABLE 8—COMPARATIVE STRENGTH OF MAJOR AND MINOR SPECIMENS—POUNDS PER SQUARE INCH

	Transverse test		Compression test			
			Parallel to grain		Perpendicular to grain	
	Modulus of rupture	Rating per cent	Maximum load	Rating per cent	Load for ⅜-in. deflection	Rating per cent
Major Specimens						
Untreated	7,028	100	3,563	100	1,007	100
Treated	4,058	58	2,595	73	687	68
Minor Specimens						
Untreated	6,150	100	4,137	100	1,117	100
Treated	4,842	79	2,781	67	745	67

The loss in strength in modulus of rupture, transverse test, is twice as great in the major as in the minor specimens. This is due to the influence of the treated sapwood, which causes early failure in treated major specimens. It is to be noted that the minor specimens were taken from the heart of the specimens, so that there was no influence of sapwood, checks or treatments on the results of the test. The loss in strength of treated major and minor specimens in comparison tests is practically the same.

It is to be noted that in every case the treated material shows a decided loss in strength, as compared with untreated. The greatest loss is in transverse strength, due to the influence of the treated sapwood. It is also to be noted that the loss in compression strength is considerable. As has before been noted, Oregon fir is very refractory to all kinds of treatment.

The subjection of the Oregon fir to high abnormal temperatures and pressures, extending over considerable length of time, causes permanent deterioration of fiber.

The purpose for which the material is intended should be taken into account in the consideration of comparative results. The transverse strength of piling is not of as great importance as the compressive strength. The loss in compressive strength is manifested in the failure of piling to withstand the sudden severe vertical stresses applied by the pile driver. It is also important that the piling have sufficient strength in shear parallel to the grain to prevent "shelling out" during the driving.

The minimum deterioration and loss of strength is obtained by the treatment of Oregon fir under as nearly normal conditions as possible. Excessive time and high temperatures of steaming should be avoided.

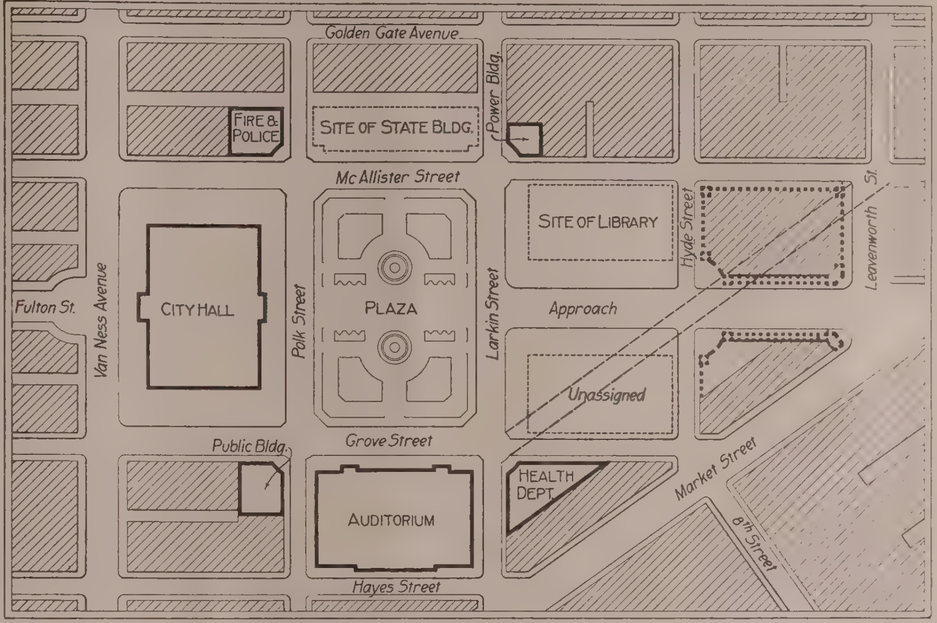
The results of this test indicate the following conclusions relative to the effect of steaming process of creosoting Oregon fir piling:

1. The depth of penetration of creosote was mainly dependent upon the depth of sapwood.
2. The heartwood of Oregon fir piling was almost impervious to treatment.
3. The depth of penetration of creosote was the same in the butts as in the tops.
4. The depth of penetration of creosote should be interpreted to mean the depth of "active" penetration.
5. Tests of minor specimens show that injury to fiber through method of treatment is not localized to treated fiber alone, but extends throughout the whole specimen.
6. The transverse strength of Oregon fir piling was decreased 42 per cent, due to the steaming process of creosoting.
7. The compressive strength perpendicular to the grain was decreased 32 per cent, due to the steaming process.
8. The compressive strength parallel to the grain was decreased 27 per cent, due to the steaming process.
9. In the general average, the strength of Oregon fir piling subjected to the steaming process of creosoting was only two-thirds its original strength.

STANDARDIZED STREET TRAFFIC REGULATIONS as an aid to safety were urged by W. P. Eno, of Washington, D. C., at the third annual Safety Congress held in Chicago recently. As a means of carrying out his idea, Mr. Eno suggested an organized bureau of street traffic; general compulsory traffic duty for all policemen, and standardized printed traffic regulations freely distributed. These, he said, would add much to the safety of the community as well as to its convenience and comfort. Conditions may be still further improved by the substitution of rotary traffic for the block system at intersections where there is sufficient space, by isles and promontories of safety, by crow's nests, by changes in car tracks and curb lines, and by one-way traffic streets.

Civic Center at San Francisco

Two Structures Nearing Completion in an Ambitious Scheme Involving Eight City Squares and a Bond Issue of $8,800,000



ARRANGEMENT OF BUILDINGS FOR NEW CIVIC CENTER IN SAN FRANCISCO

THE construction of San Francisco's $4,000,000 city hall is being rushed toward completion, and the adjoining auditorium with a seating capacity of 10,000, which is to house the Exposition engineering congress and other gatherings next year, is to be finished in November, a month ahead of schedule. Both structures are part of the civic center plan, which was not conceived until the fire of 1906 razed all buildings in this district, and made it possible to consider gathering all the city's public buildings and grouping them in an artistic manner.

RAPID WORK SINCE 1912

A number of civic center designs, involving various arrangements of buildings and grounds, were considered and compared. From among these, that shown in the accompanying illustration was finally accepted, and on March 29, 1912, a bond issue of $8,800,000 was authorized by popular ballot for carrying out the construction. At that time the city owned only the shaded triangle shown in one of the illustrations and it was not only necessary to acquire a large area and arrange for revising the street plan, as shown, but it also became necessary to wreck or remove a number of structures which had been built on the desired area after the fire and while civic center plans were under debate. One of the structures, the moving of which was described in the Engineering Record of Nov. 22, 1913, was a three-story brick building weighing 8,000 tons.

The first ground was broken in civic center construction on April 5, 1913, when work on the city hall was commenced. Soon after this work started on the Exposition auditorium, and at the present time plans are nearly completed for the library building. It was at first intended to place an opera house in the space opposite the library, but this plan was abandoned and the space is now unassigned.

The California legislature recently authorized an election for a bond issue of $1,000,000 to construct a state building across the plaza from the auditorium, and this issue will be decided upon at the state election in November. The power house and the fire and police buildings are under way and landscape gardeners took the plaza area in hand during August.

CITY HALL

The central feature of the civic center will be the new city hall, which is 300 x 400 ft. in plan and covers, with its stairways and approaches, two full city squares. It is surmounted by a dome 110 ft. in diameter the top of which is 300 ft. above street level, or 10 ft. higher than the capitol dome at Washington. Inside the building beneath the dome is a large rotunda finished in marble, running through the four stories of the building. White California granite is the finish shown on the exterior.

Both east and west facades of the structure center at the ends of approaching streets. These facades are composed of a central pediment with a large doric order, flanked with a smaller doric colonnade terminating at each end with small motives. The facade builds up from this smaller order to the large pediment, which forms a base for the central dome. By this means the unit of the facade is kept down to such a scale as is practical for the utilitarian requirements of windows and office stories, while the central motive indicates the presence of larger rooms such as council chamber and library.

Supplementary entrances to the building are provided at the ends on McAllister and Grove Streets.

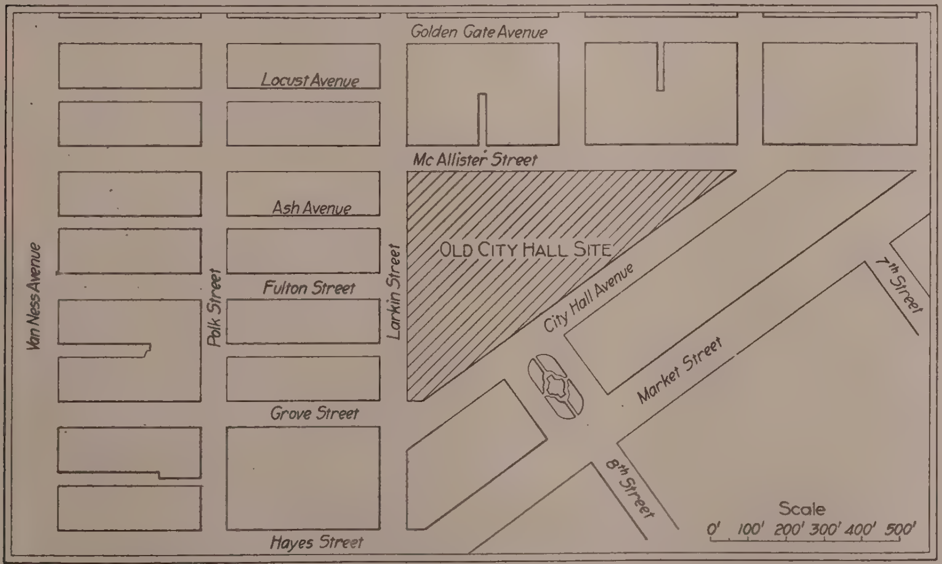
EXPOSITION AUDITORIUM

The auditorium is being constructed at a cost of about $1,300,000 as a permanent monument of the Panama-Pacific International Exposition. Although planned primarily to accommodate conventions and other similar gatherings, provision is made for converting the main hall into a ball room, or even a stadium to accommodate a horse show or circus. To accomplish this only five thousand seats were planned for the main floor and an equal number were arranged in a large balcony commanding an extensive view of the floor. Twenty-five entrances are provided, and for emergency exit there are forty-one double doors and twelve wide stairways to the balcony.

The building itself is 265 x 402 ft. in plan and consists of the main hall flanked on either side by wings to be used for offices, committee rooms or exhibits. The main hall is octagonal, 200 ft. in diameter, and its gallery projects upon three sides. Light is admitted through an octagonal glass dome, 108 ft. high to the center, which is one of the striking features of the hall.

The dome is not carried by the frame of the building, but rests on a circular I-beam making a ring 200 ft. in diameter, and supported by eight main columns. The columns are encased so as to harmonize with the interior finishing, but the steel work of the dome is finished artistically and left exposed. Artificial lighting is provided by the semi-indirect method with 500-watt tungsten lamps shielded by cone reflectors and placed at intervals of 18 in. in a central ring of the dome 40 ft. in diameter.

The plans for the civic center were developed under the direction of J. G. Howard, F. H. Meyer and John Reid, Jr., who acted as a board of consulting architects for the city and also designed the auditorium. Bakewell & Brown, of San Francisco, were the architects for the city hall.



SITE OF OLD CITY HALL PRIOR TO DEVELOPMENT OF CIVIC CENTER

Proposed Water Storage on the Upper St. Maurice River, Province of Quebec

Part II—Main Features of Reservoirs of 160,000,000,000 Cubic Feet Capacity to Regulate the Flow of the River

By JOHN WOLF THURSO
Civil and Hydraulic Engineer, Montreal, Canada

THE main features of the proposed dam at La Loutre, on the upper St. Maurice River, in the Province of Quebec, to increase the low-water flow of the stream were described in the Engineering Record of October 10, page 394. Important accessories not mentioned in that article include the racks, stoplogs, gates and jib cranes. The latter, of which there will be two, will be equipped with various attachments and will be useful for a variety of purposes.

RACKS AND STOPLOGS

Racks for sluice gates and turbine inlets consist of 9-in. 16.86-lb. bulb-plates on 9-in. centers. They are placed at an angle of 45 deg. The rack is divided into removable sections of six bars each, the weight per section being 3300 lb. Each turbine inlet is further provided with two fine racks, one in front of the other. These racks are counterbalanced and so arranged that when the second is let down the first may be raised above the top of the dam and cleaned.

Double stoplog slides are provided at both ends of the gate tunnels. For the downstream end of each tunnel stoplogs of the usual type are to be used, while for the upstream end the stoplog sections consist of three 12 x 12-in. longleaf yellow-pine or Douglas-fir timbers. Owing to the great depth of water special devices had to be designed for raking the racks, removing sunken trees, logs and roots in front of them and lowering and raising the stoplog sections. All of these devices are to be handled by traveling jib cranes.

An 8-in. suction pipe is located over the downstream outlets of the tunnels and connected to the 5-in. pump. At each tunnel is a gate valve to which a galvanized, spiral-riveted steel pipe, reaching nearly to the bottom of the tunnel, will be attached when the tunnel is to be emptied of water.

GATES

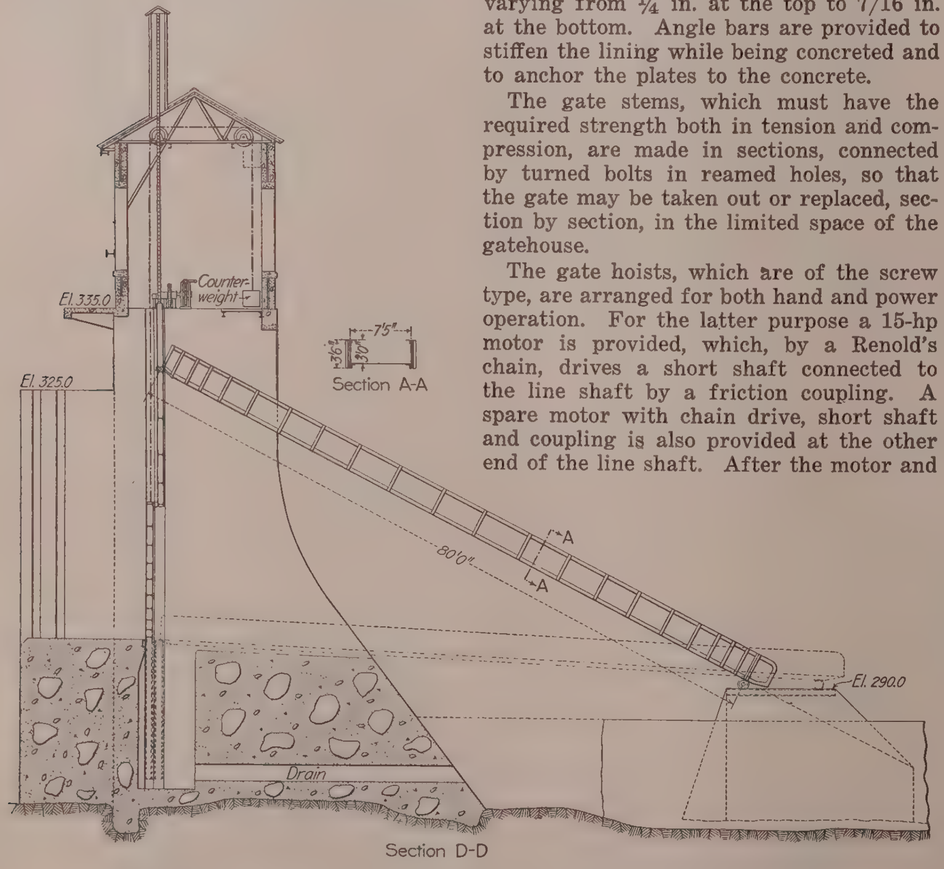
As the amount of power and time required to raise or lower a gate is of no importance, it was decided that plain sliding gates would be preferable to the more complicated Stoney or similar types. All gates are to be of structural steel and designed with a safety factor of four, while for the gate hoists and stems the same factor is to be taken with a friction coefficient of 0.625 for the gate slides.

The sluice gates, ten in number and having a clear opening 7½ ft. wide by 12 ft. high, are of a simple design. On each gate slide will be a removable, planed-steel wearing strip, and the gates will have similar strips of bronze. The sill is a steel casting sloping downstream 6 in. in 2 ft. to reduce the scour, which experience has shown to be particularly great at this point when the gate is only partly open. For the same reason the lower edge of the gate will be provided with a removable wearing plate.

The tunnels are lined with steel plates varying from ¼ in. at the top to 7/16 in. at the bottom. Angle bars are provided to stiffen the lining while being concreted and to anchor the plates to the concrete.

The gate stems, which must have the required strength both in tension and compression, are made in sections, connected by turned bolts in reamed holes, so that the gate may be taken out or replaced, section by section, in the limited space of the gatehouse.

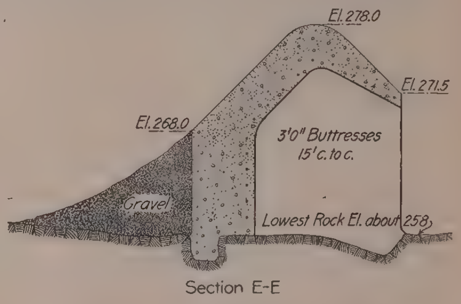
The gate hoists, which are of the screw type, are arranged for both hand and power operation. For the latter purpose a 15-hp motor is provided, which, by a Renold's chain, drives a short shaft connected to the line shaft by a friction coupling. A spare motor with chain drive, short shaft and coupling is also provided at the other end of the line shaft. After the motor and line shaft have been started in the proper direction the operator may move any gate by throwing in a clutch. An automatic throw of the hoist clutch when the gate has reached its highest position is provided, and an automatic circuit breaker will cut off the current when the gate reaches the bottom sill.



ELEVATION OF LOG SLUICE SHOWING DOUBLE GATE AND STEEL TROUGH

The turbine intakes have the same general arrangement of the coarse racks as for the sluice gates. The two gates are of the same general design as those for the sluices, with a clear opening 7 ft. wide and 6 ft. high. The hoists are for hand operation only.

The gate for the open sluice is for a clear opening 7½ ft. wide by 33 ft. deep, or from El. 328 (top of flashboards) to El. 295. The gate consists of two sections, which may be lowered into the well provided for this purpose, and are so arranged that, when lowering, the upper section will move alone until its upper edge is level with the upper edge of the lower section, after which the two sections will move down together. When raising, the two sections will move together until the lower one has reached its highest position, after which the upper section will continue its upward movement alone. By this arrangement the load on the hoist is only about one-quarter of what it would have been had the two sections moved together—that is, when the frictional load due to the water pressure for the full depth of 33 ft. had to be overcome.



DETAIL OF MEASURING WEIR

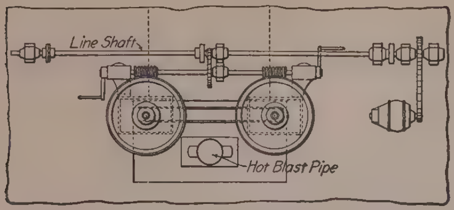
The gate has the same steel and bronze wearing strips as the sluice gates; its hoist is for hand operation only and the lower section is counterbalanced. The adjustable channel is, at its upstream end, hinged to the upper gate section, while at the downstream end wheels are provided running on tracks supported by the concrete walls. The channel itself consists of two plate girders connected by a plate forming the bottom. A live load of 600 lb. per linear foot was assumed for the design.

In operation the top of the gate will be lowered from 1 to 3 ft. below the surface of the water to skim off any matter floating on the reservoir.

HEATING OF WELLS

It is important to prevent freezing of water in the gate wells, as such ice would prevent the operation of the gates. The engineers of the Shawinigan Water Power Company kindly gave the benefit of their experience, which was, briefly, that the best way to prevent formation of ice is to direct a blast of hot air against the surface of the water and that for heating 1 watt per cubic foot of space of the gatehouse had proved more than sufficient, a value which is, of course, entirely empirical.

The difficulty of the proposition in hand was the variation of 50 ft. in the water level in the wells. To overcome this a telescoping pipe was adopted with a float



PLAN OF GATE OPERATING MACHINERY

at its lower end of sufficient buoyancy to carry the weight of the three telescoping sections. This float is to be of steel, heavily galvanized. As a fan builder, however, offered to guarantee that an air current discharged downward into the wells with a velocity of 50 ft. per second from a nozzle having its mouth at about El. 330 would reach the water surface even when at its lowest stage, this plan will be tried first and only if it is unsuccessful will the telescoping pipes be installed.

At each end of the gatehouse is located a fan and heater, one being a spare outfit. The apparatus is located overhead, out of the way, and both fans discharge into a common trunk of rectangular section. As the air in the trunk may move in either direction, according to the fan in use, the branches are connected to the trunk by conical pieces having an oval section at the larger end. The branches for the turbine inlet wells have an offset to clear the ropes for hoisting and lowering the racks. When the gate is to be taken out or replaced, the branch for that well is removed by unbolting the flange joint at the small end of the cone, the latter being riveted to the trunk.

Each fan has a capacity of 15,000 cu. ft. per minute. They are provided with electric heaters consisting of four sections of 20 kw each, so that either fan can be supplied with 20, 40, 60 or 80 kw for heating. The fan at the west or power-plant end is also provided with a steam-coil heater, so that when the steam engine is in use either current or steam may be used. The fans draw the air through the heater from the highest part of the building and discharge it upon the surface of the water in the wells, whence it rises upward into the gatehouse.

By selecting the fans of such a size that they will require 15 hp each for the desired air capacity and proportioning the chain gearing of the gate hoists so that their motors will run at the same speed as the fan motors the four motors are interchangeable.

JIB CRANES

The gatehouse jib cranes are to serve a variety of purposes. There will be one right-hand and one left-hand, one to be considered a spare except when a load beyond the power of one crane is to be lifted. Each crane has a normal capacity of 4000 lb., with an automatic release when the load reaches 6000 lb. The boom, 25 ft. in length, swings in a horizontal plane through an arc of 180 deg.

Three motors are provided, for hoisting, traveling and boom swinging. The hoist rope ends in a pair of sister hooks to make connections with the various attachments. These are a ball hook, for general hoisting, a plain hook for hauling and pulling booms, boats, etc., a rake for cleaning the coarse racks of roots, branches, etc., a grapple for bringing to shore floating logs and removing sunken logs and trees from in front of the racks, a spreader, having at each end a pair of sister hooks, for handling the stoplog section; a spreader with two plain hooks for taking sections from trucks on top of the dam and lowering them into the stoplog slides; spreaders with two hammers for pounding down the stoplog sections when, owing to some accident, a gate cannot be closed, as in this case the rush of water through the gate would seriously interfere with getting the sections down, and a spreader with weighted hooks for removing the stoplog sections from the slides. The hammers and weighted hooks are guided by fitting loosely around the bulb of a bulb-plate, set into the concrete forming the slide and having an angle bar on each side to form a smooth sliding surface.

BUILDINGS

To reduce the heat radiation to a minimum the walls of the building over the gate hoists and the power plant are to be double, consisting of two 8-in. walls, built of 8 x 8 x 16-in. hollow concrete blocks, with a 2-in. air space between. Molded concrete tie blocks will be used to connect the two walls, as steel ties might rust in the air space.

For the roof covering of both buildings Siegwart hollow-concrete beams about 9 in. deep will be used. Fenestra double windows are specified. The doors, like those of a refrigerating plant, will be hollow and the interior will be filled with non-conducting material.

MEASURING WEIR AND FLOW RECORDS

The type of the measuring weir being somewhere between a gravity and a hollow section was adopted for the reason that in the basin formed by the main dam and the weir, the expansion of the ice may be expected to exert its full force. In that case the sloping upstream face of the weir will permit the ice to slide upon it. In this instance no freezing of the ice to the deck is possible, as even with all the gates closed there would still be a thin sheet of water continuously flowing over the weir, due to the gate leakage, not to mention the discharge from the turbine, which would be running to supply current for heating.

The water-level recording apparatus is in duplicate, with the exception of the transmission line, one set being a spare one. In the west abutment of the weir is a well in which are floats, one for the water level upstream and one for that downstream of the weir. In the small house above the well is the apparatus which transmits the stage of the water to the duplex recorder in the building above the gate hoists. This instrument records both the upstream and downstream water level on weekly cards. By throwing a switch at each end of the transmission line the spare set of floats, transmitter and recorder may be brought into service.

OPERATION

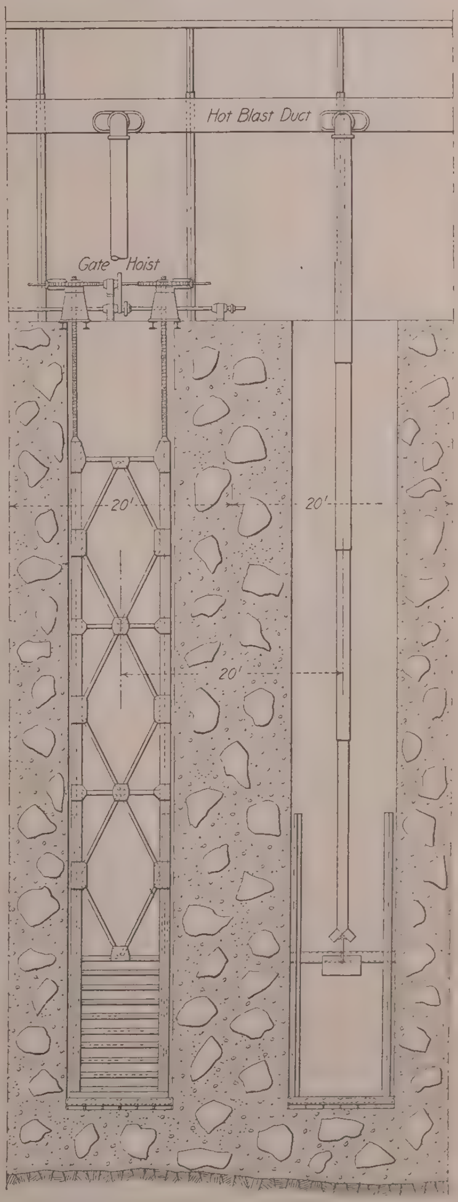
For the greater part of the year—that is, as long as the flow on the lower reaches of the river does not sink below a certain minimum—all gates will be kept closed. As that minimum is about to be reached, water will be fed out from the reservoir to make up the deficiency, the quantity discharged increasing with the decrease in flow from the drainage area below the storage dam.

No mass curve has yet been made, but it is expected to maintain at Shawinigan, some distance down the river, a minimum flow of 12,000 or 14,000 sec.-ft. throughout the year, while at present the low-water flow at that place sinks to less than 6,000 sec.-ft.

With a common overflow weir, it would be an easy matter to give the operator at the dam the quantity to be fed out by stating in feet and tenths the depth of water to be run over the measuring weir, but in this case as soon as the quantity discharged goes beyond 3300 sec.-ft. the downstream water level rises above the weir crest and the weir becomes submerged. To this is added the further complication that during winter for any given flow from the reservoir the water level downstream of the weir is not necessarily at a definite elevation but may vary with the varying quantities of ice in the river.

At La Loutre the operator will be given the approximate depth of water to be run over the weir. After a couple of hours, when the flow has become steady, he must report the elevation of the water level downstream of the weir, and the depth over the latter will then be adjusted, according to curves plotted for the purpose, to correspond to the quantity to be discharged.

Another difficulty will be to decide just when to start feeding out water and when



ELEVATION OF GATE AND GATE RECESS

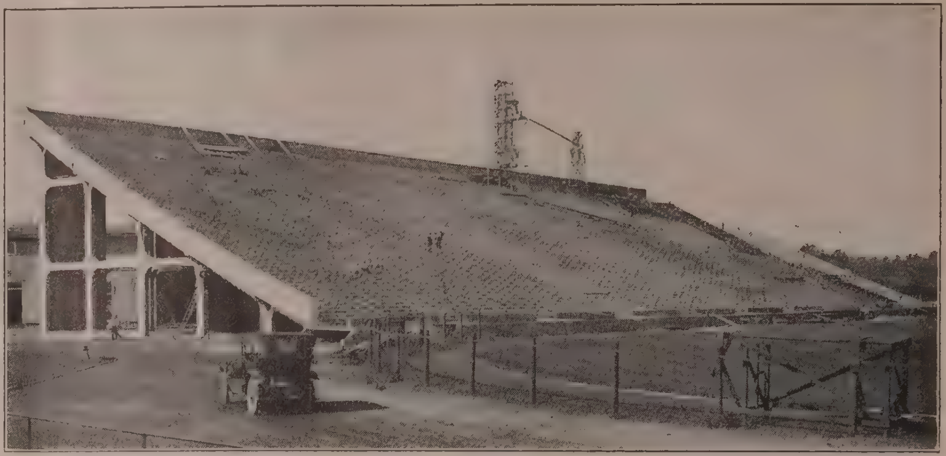
to increase the discharge, as according to the experience of the St. Maurice Hydraulic Company with the Manouan reservoirs it will take about fourteen days, more or less, depending on the quantity discharged, before the effect of the water from the La Loutre reservoir will be felt at Shawinigan.

No estimate of the cost of construction can be given at present, but it may be said that for every dollar spent in constructing the storage works at Assuan, as they are to-day, there is an available storage of 4140 cu. ft., while for every dollar spent in constructing the La Loutre works there will be an available storage of from 75,000 to 100,000 cu. ft.

The Quebec Streams Commission is a body appointed in December, 1911, with the Hon. S. N. Parent as chairman and placed under the Minister of Lands and Forest. The writer had charge of the design of the entire works, having been engaged in January, 1913. Edward Wegmann, of New York City, was the consulting engineer.

Stadium for University of Michigan

First Section of a Large Reinforced-Concrete Structure, Which When Completed Will Provide Seats for 47,680 Spectators



VIEW OF COMPLETED UNIT OF STADIUM AT UNIVERSITY OF MICHIGAN

CONSTRUCTION of a reinforced-concrete stadium, which when completed will provide permanent seats for 47,680 spectators and temporary seats for about 5000 more, has been begun for the Athletic Association of the University of Michigan. It will replace the present timber stands. The plans call for a horseshoe-shaped structure. Only one unit, having a length of 396 ft. and a depth of 121 ft. 8 in., is now under construction. The front of the stand is 43 ft. from the side lines of the field and the first row of seats is 4 ft. 6 in. above the field level.

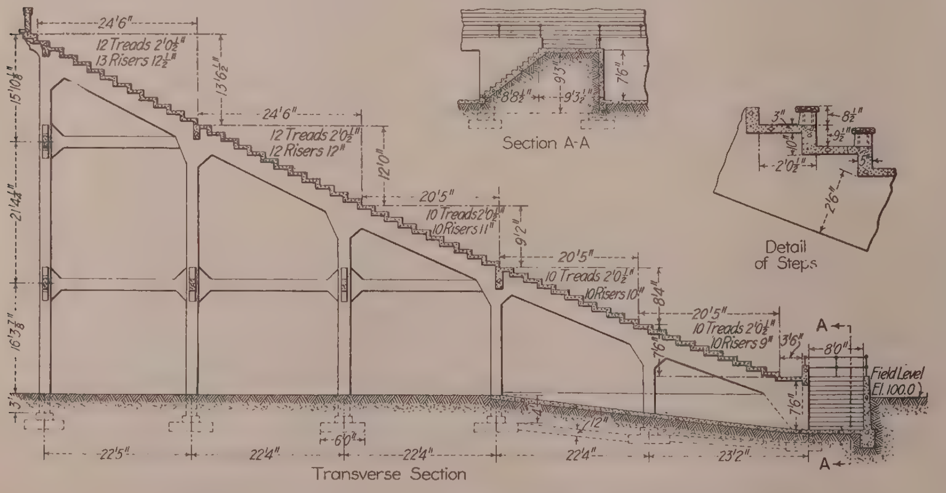
SEAT TIERS

There was considerable difference of opinion as to the proper width of tread, but a uniform width of 24½ in. was finally chosen. If a tread 36 in. wide could have been adopted it would not have been necessary for people to rise in order to let others pass. This width was evidently out of question. Having adopted a uniform width of 24½ in., the theoretical height of each successive riser was computed by similar triangles, assuming the line of sight from each spectator to the near side line as 4 in. above the head of the person directly in front. The result gave a bottom riser of approximately 9 in. and a top riser of approximately 12½ in. In order to simplify erection it was decided to use a series of tangents instead of the theoretical curve of risers, making the changes in direction at or near the columns. The adoption of 9, 10, 11, 12 and 12½-in. risers resulted in a close approximation to the theoretical curve, the clearance of lines of sight being slightly less than 4 in.

One of the illustrations shows a cross-section of the stand and the main details of the construction. Each section of seats, occupying a 30-ft. width with a 3-ft. aisle, is reached by an inclined passage excavated to a depth of 5 ft. below grade. It is 16 ft. wide and connects with a stairway 8 ft. wide ending directly in front of the aisle. The stands are fifty-five rows high and the present unit calls for twelve sections seating 1100 each. There are twelve main and two end entrances for this section.

The seats will all be 18 in. above the tread next below. This is accomplished by using a small concrete pedestal varying in height inversely as the height of the riser. To these pedestals 2 x 10-in. planks, each the full length of the section (30 ft.), are fastened.

The assumptions as to unit stresses and load distribution followed those of the report of the joint committee. The assumed live loads were as follows: Treads and risers 125 lb. per square foot, main girders and columns 100 lb. per square foot, and lateral pressure 50 lb. per square foot. Risers were assumed as semi-T beams, while the main girders were considered as rectangular beams.



SECTIONAL ELEVATION AND DETAILS OF DESIGN FOR STADIUM

EXPANSION AND CONTRACTION

Professor Gram of the engineering department of the university, acting as joint adviser of the board in charge of the construction, considered the expansion due to moisture more important than that due to temperature. The entire exterior will, therefore, be waterproofed with some coating not yet decided upon. No expansion joints are provided, but additional reinforcement is used to take up expansion and contraction stresses. In the treads one ½-in. and one ⅝-in. bar are used, running the full length of the stand. From top riser to bottom riser, No. 8 wire was used, spaced 6 in. on centers.

In order to reduce to a minimum the bending moments in the columns, due to lateral or other forces in a direction parallel to the long axis of the structure, 8-in. diaphragm walls were used three in each row of columns. The main girders are designed to carry the total lateral pressure perpendicular to the long axis of the structure to their lower ends, where it is resisted by the footings of the three front rows of columns. These are connected by a 12-in. reinforced-concrete wall.

CONSTRUCTION

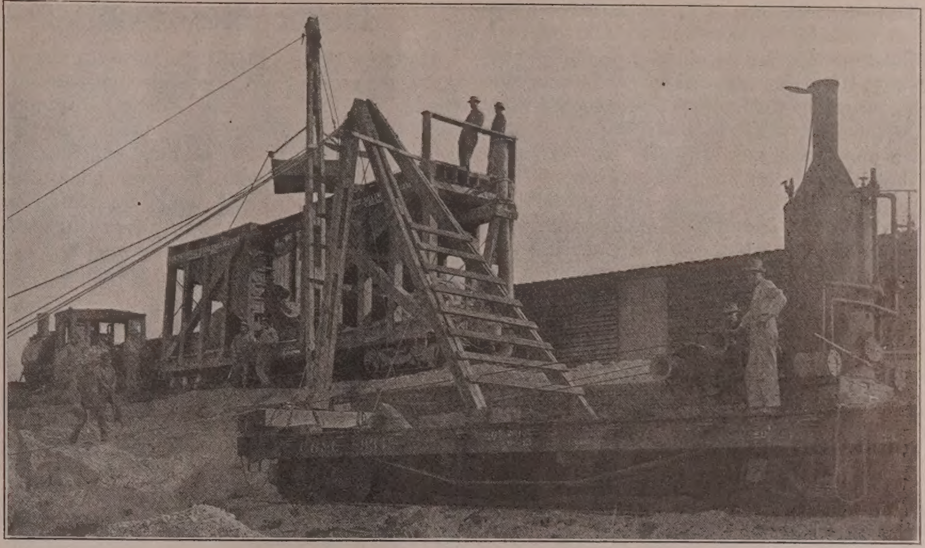
Borings made on the building site indicated clay sub-soil good for 3000 lb. per square foot. The Detroit building code allows 8000 lb. for the same material. The footing plan was made on that basis, the dead loads only being considered in proportioning the bearing stresses. A footing 6 ft. square and 1 ft. 3 in. thick reinforced with ½-in. Kahn rib bars was used. All columns were made 18 in. square, reinforced with 4-in. rib bars and tied every 12 in. with ¼-in. round bars. The most interesting feature of the construction was that bulk cement was used throughout.

The unit under construction will cost $55,000 and has required 300,000 ft. b.m. of lumber, 5000 bbl. of cement, 3750 cu. yd. of gravel, 2000 cu. yd. of sand, 150 tons of reinforcing steel and 3000 cu. yd. of excavation.

The plans for the stadium were prepared by H. J. Weeks, of Detroit, Mich., who also supervises the construction as engineer of the Board in Control of the Athletic Association of the university. Dean Cooley and Professor Gram acted as advisers to the board, checking and approving all designs and calculations.

Tunnel Lining with Compressed-Air Plant

Notes on Work of Outfit Used on Bore on New Line of Chicago Burlington & Quincy Railroad Near Casper, Wyoming



DERRICK CAR LOADING BINS ON MIXER CAR WITH HOME-MADE SKIP

COMPRESSED air is being used in lining the 800-ft. summit tunnel between Casper and Thermopolis, Wyo., on the new line of the Chicago, Burlington & Quincy Railroad connecting Thermopolis and Orin Junction. The tunnel was excavated a year ago in rather treacherous sandstone, which required timbering throughout its length. It is now being lined with concrete and the timber is being removed as the concrete lining is placed.

The tunnel is approached with long cuts on both ends—nearly a mile at the west end and about half a mile at the east end. Material for the concrete is brought in gondola cars from Casper, where the sand and gravel are dredged from the river. This material is stored alongside the main line near the entrance to the tunnel approach.

Three operations constitute the work of lining the tunnel; these are first, the removal of timbers; second, the erection of the Blaw steel forms, and third, the mixing and placing of the concrete. The timbers are pulled down by a dinkey engine, cables fastened to the bottoms of the uprights passing through snatch blocks placed in the center of the track. When the posts are pulled out the débris is cleared away and the loose rock is picked down to insure the safety of the men erecting the forms. To protect the men further, planks are laid from the remaining timbers to the concrete to catch any small pieces of rock or give warning in case a large rock should fall. From 5 to 20 ft. of timber, depending on the condition of the rock, are removed at one time.

Erection of the forms consists of placing a steel channel rib, which fits the section of the tunnel, and connecting it with the last rib previously placed by means of steel plates 4 ft. long and 3 ft. high. These plates are built up solid to the top of the arch, as the concrete, placed by the compressed-air method, allows the forms to be built complete before concreting begins. The steel ribs of the forms are 4 ft. apart, corresponding to the length of the plates, and from one to five sections are set up at a time, according to the length of timber removed.

THE OUTFIT

The mixing and placing outfit consists of a pneumatic concrete mixer and conveyor mounted on a 40-ft. flat car, equipped with bins holding 26 cu yd. of material. The cement is stored in bags under one of the bins and discharged toward the center of the car through chutes into a measuring hopper. This measuring hopper is lifted and tilted automatically to discharge into the mixer. The lifting device is a 6-in. air cylinder. The 8-in. delivery pipe leads from the mixer under the car and vertically up at the end of the crown of the arch, where a 90-deg. elbow enters through the bulkhead of the form. Air is supplied from a compressor at the mouth of the tunnel through a 4-in. main laid on brackets fastened to the timber posts, and a connection is afforded from the main to the air receiver on the car by means of a hose. This car was described in the Engineering Record of March 21, page 327.

The proper size of compressor to run a portable outfit of this kind is believed to be about 300 cu. ft. capacity of free air per minute, compressed from 80 to 100 lb. In beginning the work, however, a compressor of 134 cu. ft. capacity was furnished by the railroad from one of its yards, as this was the only compressor available at that time. This compressor was operated by a gasoline engine and was found to be badly worn and inefficient. The amount of air furnished by the compressor was approximately 80 cu. ft. per minute. This is thought to have reduced the output of the mixer and conveyor and is mentioned because it applies to the data given below.

OPERATION

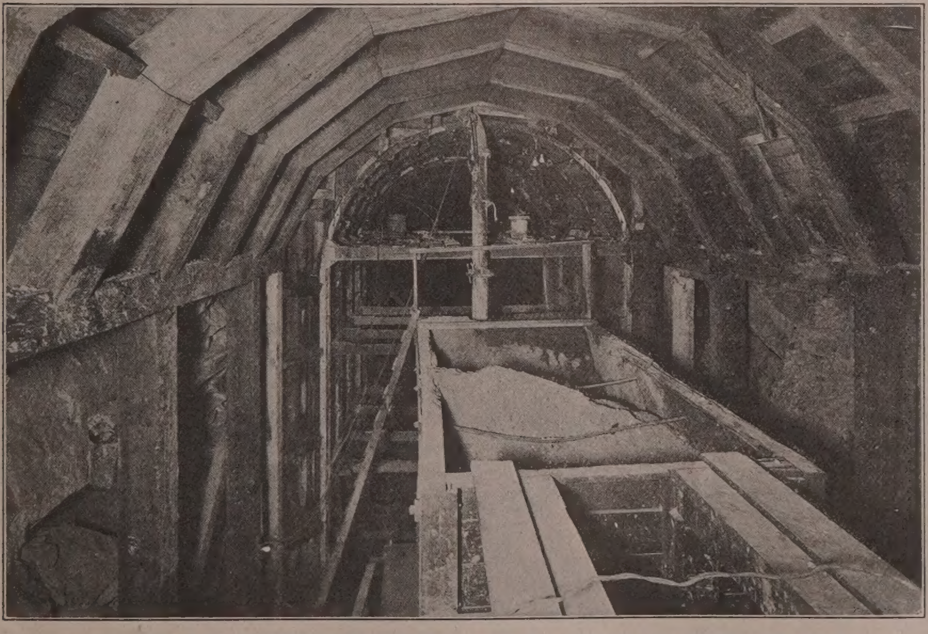
The car is taken into the tunnel by means of the dinkey engine and spotted at a point next to the forms. The upper elbow of the delivery pipe is previously suspended in place so that when the car is "spotted" the upper pipe was bolted to the pipe on the car, which comes directly under it. The air connection is then made and concreting immediately begun.

The car is loaded by means of a portable derrick, which handles a wooden skip, as a clamshell bucket was not at first available. This wooden skip is loaded by several men shoveling the bank-run gravel into it, and is then lifted above the bins on the car and dumped into them.

The first work done by the outfit, which embraced the lining of the first 20 ft. of forms, required five carloads of concrete material to fill the form. The entire work of tearing down timbers required 128 men-hours, the total time erecting forms was 229½ men-hours, the time loading gravel and cement on the car required 140 men-hours and the total time required for mixing and placing the concrete in the forms was 204 men-hours. The total yardage placed was 132 cu. yd. From these figures it is seen that the number of men-hours required for the various items per cubic yard of concrete was as follows:

Item.	Men-hours per cu. yard
Tearing down and cleaning timbers	0.97
Erecting forms	1.74
Mixing and placing concrete	1.50
Loading gravel and cement	1.06

There were 3½ hr. delay on account of blowing off and replacing an 8-in. nipple and 2 hr. delay on account of a derailment.



DELIVERY PIPE ENTERING FORMS THROUGH BULKHEAD AT CROWN OF ARCH

The substitution of a clamshell bucket when available is expected to cut the cost of loading the car to about 1/3 men-hour, or say 10 cents per cubic yard, and the substitution of a 300-cu. ft. compressor will, it is thought, make it possible to mix and place one batch per minute. The number of batches on the car varies between 112 and 118. The time required at present to unload one car, including time of transporting and of connecting and disconnecting the pipe, is from 3½ to 4 hr.

The concrete mixer and conveyor used for the work was furnished and the portable outfit was designed by the Concrete Mixing & Placing Company, of Chicago.

Traffic Census of Concrete Roads in Milwaukee County

A TRAFFIC census on some of the concrete roads in the county leading out of Milwaukee was taken in August and September. Between 6 a.m. and midnight on Sunday an observer on the Blue Mound Road counted 2493 automobiles, 29 auto trucks, 439 motorcycles and bicycles, 94 single horses, 3 light teams, 17 heavy teams, 45 people on the walk and 161 on the road. The peak hour for automobiles was from 5 to 6 p.m., when 280 machines were recorded. During the same day from 7 a.m. to 10 p.m. the Janesville Plank road was traversed by 1096 automobiles, 11 auto trucks, 266 motorcycles and bicycles, 208 single horses, 11 light teams, 45 heavy teams, and 454 pedestrians all on the road. The same road on the following Thursday during the whole 24-hr. period carried 294 automobiles, 29 auto trucks, 126 motorcycles and bicycles, 269 single horses, 26 light teams, 249 heavy teams and 284 pedestrians. The automobiles were most prevalent, 28, from 5 to 6 p.m., but another peak of 27 was noted between 8 and 9 p.m. Heavy teaming was at its maximum, 24, between 1 and 2 p.m. It disappeared suddenly at 8 p.m.

On Friday, Sept. 4, a 24-hr. census taken on the Green Bay Road indicated 376 automobiles, 20 auto trucks, 224 motorcycles and bicycles, 197 single horses, 23 light and 163 heavy teams, 184 pedestrians on the walk and 219 on the road. The same peak shows between 6 and 7 p.m. with 37 automobiles, but this road was more popular from 4 to 6 p.m. than later in the evening. Heavy hauling was over by 6 p.m. Some pedestrians walked the street every hour except from 1 to 2 a.m.

The census was taken by the Milwaukee County Highway Department, of which H. J. Kuelling is engineer.

GROSS OPERATING REVENUES FOR JULY on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1124 per mile, showing a decrease of $59 or 5.0 per cent as compared with July, 1913. Operating expenses were $785, showing a decrease of $52 or 6.2 per cent. Net operating revenues were, therefore, $339, showing a decrease of $7 or 2.1 per cent. The operating ratio was 69.8 per cent, as compared with 70.7 per cent in July, 1913, and 68.1 per cent in July, 1912. Considering the three main districts, the respective ratios for July, 1914, and July, 1913, are as follows: Eastern district, 70.8 and 72.1; Southern district, 75.2 and 75.3; Western district, 66.8 and 67.5.

Book Reviews

Bulletin 101 of the U. S. Department of Agriculture by C. H. Teesdale, engineer in forest products at the Forest Products Laboratory, Madison, Wis., treats of the relative resistance of various conifers to injection with creosote. The paper contains forty-three pages, and includes numerous curves and tables showing the results of penetrance tests. (Washington, D. C., Government Printing Office, 15 cents.)

The annual report for 1912-1913 of the Water Power Branch of the Department of the Interior, Dominion of Canada, has just been issued. It has 216 pages 6½ x 9¾ in., and a number of text figures and inserted plates. Several larger power developments have been briefly described and an account has been given of hydrographic and power surveys, the Winnipeg River power and storage investigations, construction work proceeding under the supervision of the Water Power Branch, reclamation, etc. (Ottawa, Canada, Department of the Interior.)

The report on irrigation in Canada for the year 1913 has appeared in printed form, containing 172 6½ x 9¾-in. pages. The book treats of the early history of irrigation in Western Canada, the Maple Creek District, the Calgary District, special inspections, the cost of small irrigation schemes, the South Saskatchewan River diversion project, the Belly-St. Mary River diversion project, stream measurements, the flood discharge of the Bow River, floods in the North Saskatchewan River drainage basin, and rating current meters. (Ottawa, Canada, Department of the Interior.)

PUMPING BY COMPRESSED AIR. By Edmund M. Ivens. Cloth, 6 x 9 in.; 244 pages; 106 illustrations. New York: John Wiley & Sons, Inc. $3 net.

The air pump is rapidly increasing in importance as an apparatus of general engineering utility. Not only is it used for the immediate purpose of conveying the fluid required, but it is embodied as part of apparatus in various other machines. Thus, the General Electric Company has lately constructed for laboratory purposes a nitrogen generator which is essentially a modified air-lift pump. Similar apparatus is being introduced in Germany in sulphuric-acid manufacture. This makes a clear comprehension of the essential principles underlying the design of compressed-air pumping especially valuable for a large class of people, and a book presenting it in readable form, without unnecessary mathematical embellishments, is very welcome at the present time.

Mr. Ivens, in the first eight chapters of his book, gives a general, well-illustrated description of the design and construction of the various types of pumps on compressed-air systems, such as the displacement pump, return air system and air lift. Particular attention is paid to this latter type, which is steadily gaining in popularity in this country. The author gives data on submergence, equipment, general design and the performances of various types, and describes various commercial systems.

Chapters nine and ten cover what the author calls compression generalities, and shows the way of using the indicator in air-compressor practice and utilizing its indications. This is a very valuable part of the book, as there are comparatively few works in which various compressor efficiencies are explained in an equally clear and simple manner. The two last chapters, on the flow of compressed air in pipes and the flow of water in pipes, present information which a designer of compressed-air pumping machinery will find it useful to have at hand.

The book is well illustrated and contains a considerable number of tables. No complete bibliography of the subject is attached, but references in many instances are made to previous investigations.

INFLUENCE DIAGRAMS FOR THE DETERMINATION OF MAXIMUM MOMENTS IN TRUSSES AND BEAMS. By Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. Cloth, 6 x 9½ in.; 65 pages, 42 illustrations. New York, John Wiley & Sons, Inc. $1.25.

(Reviewed by F. H. Constant, Professor of Civil Engineering, Princeton University, Princeton, N. J.)

In this small volume of 65 pages the author shows first that the influence diagrams for bending moments in all types of simply supported trusses can be drawn in accordance with a single and very simple rule, recognized by writers but never so clearly demonstrated as here. This rule depends for its statement and notation merely upon the relative horizontal positions of the center of moments (whether within or without the span), the supports, and the ends of the stringer cut by the section through the truss. Its universality is tested by successive applications to several types of trusses, including the Pratt, with horizontal and curved chords and with vertical or inclined posts, trusses with various kinds of subdivided panels and with chords not parallel, arched simple trusses having the center of moment between the supports, the so-called K-truss (in which the web members form a series of the letter K), and double intersection trusses of the Whipple and double triangular types, including that with subdivided panels. The rule is clearly applicable to web members as well as chords. The relation between the influence diagrams and the criterion for the position of wheel loads giving maximum moments is pointed out, and the criterion is either developed or stated for each case illustrated.

Continuous trusses (including swing bridges) and arches are considered in chapters 3 and 4 and it is shown that the moment influence diagrams for the simple truss are founded upon what, for convenience, is called the base diagram. In both cases the moments at the ends of the span containing the member under consideration must be known, and for the arch the horizontal thrust likewise. Equation (d) on page 42 and (e) on page 54 express the relationship by which, by the addition of one or two lines, the base diagram can be modified to fit these cases.

The influence diagram for the three-hinged arch shown in Fig. 36, page 55, where there is no floor beam over the center hinge, is manifestly an error in having an apex under the center hinge. The triangular diagram for the horizontal thrust, drawn with the vertex under the center hinge, should be truncated between the adjacent panel points on either side of the center. For a similar reason the equation at the top of page 56 is incorrect.

In the last chapter the method is applied to beams of constant cross section, and with or without restrained ends.

The book will be of value in the class room and presents what is generally a troublesome subject for students to grasp in a clear and logical manner.

Letters to the Editor

Fair Play

SIR: I was very glad to see in your issue of Oct. 17, page 419, the editorial entitled "Fair Play," praising the improvement in the New York State Highway Department. It was but a short time ago that this department was filled up with engineers "by appointment." These are now entirely replaced by engineers "by education and experience." I hope the Engineering Record will maintain this interest in public affairs until all engineering positions are filled by real engineers. The records of all applicants and appointments to government engineering positions should be looked up and published, for it is impossible for capable engineers to do good work when subordinated to fake engineers who are always afraid some one will find out their bluff and who are jealous of engineers possessing engineering knowledge and experience.

The engineering publications should also endeavor to get the engineering societies interested. In the older professions the societies take an active interest in legislation and in appointments affecting their profession. Two of the engineering societies have waked up to their responsibilities. The American Society of Consulting Engineers and the Technology Club of New York sent representatives to the Governor of New York to urge him to appoint engineers to the Public Service Commission.

Engineers themselves need awaking to their duties as citizens. They have become so accustomed to this state of affairs that they consider the situation hopeless. Some so condemn the present political methods that they will have nothing to do with politics. If, however, politics is not so clean as they think it should be, that is all the more reason they should take an active interest in it. But unfortunately many do not vote at all and few enroll, so they have no voice in election or in the selection of candidates. If they attended to these duties they would receive more consideration and the profession would be better recognized. ALPHA.

Replacing a Washed-Out Railroad Bridge

SIR: In your "Current News" of Oct. 3 is an illustrated notice of the moving into place of a Pennsylvania Railroad bridge. It is there stated that in the flood of March, 1913, this bridge had been washed 47 ft. downstream, and had been repaired and put in temporary service in that location; and, with the addition of a new span, had been rolled back to its former position after new masonry had been built for it. If a bridge can be washed 47 ft. downstream, piers and all, and yet remain in such condition that it could be made to carry traffic by temporary repair work, I would like to see that bridge.

This structure was Bridge 100, on the lines of the Pittsburgh, Cincinnati, Chicago & St. Louis Railway, over the Muskingum River, 4 mi. west of Coshocton, Ohio. It formerly consisted of four spans resting on masonry and pile piers considerably older than the steel. In the flood mentioned, the west river pier went out, carrying the two westerly spans with it; and the center pier settled several feet, taking one end of the east center span with it. The gap was closed with a pile trestle, replaced as fast as possible with deck girder spans on pile piers, the settled span jacked up and supported on a heavy crib and a large pile cluster, and traffic resumed. This itself was considered quite a feat, to say nothing of carrying traffic over steel spans that had been washed 47 ft. downstream! The new bridge is longer than the old, but comprises only three spans, requiring but two channel piers. These and the abutments were put in by the caisson method, under the patchwork structure, and without interfering in any way with traffic.

While they were being built, there were also constructed four temporary piers, consisting of concrete mats, one of which had to be supported on crib and pile work, immediately downstream from, and in line with, the permanent piers and abutments. On these mats were erected heavy timber bents. The new steelwork was erected in the usual manner, the ends of the spans resting on the timber bents. The falsework was removed from beneath the spans as they were completed, leaving the new bridge supported on the bents and temporary piers. Traffic was then diverted over the new structure while the old patchwork bridge was removed. As the final step, the new spans were rolled upstream between trains and landed on the permanent piers. This method was adopted in preference to "changing in" the new steelwork with the old, which has been successfully done elsewhere; as the heavy double-track traffic and the facts that the new bridge is at a higher elevation than the old and that none of the new supports coincided with the old, would have made the latter procedure complicated and slow.

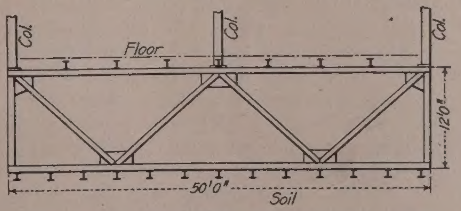
The old bridge was repaired and put in service by the Pittsburgh Construction Company. The new piers and abutments were constructed by the Foundation Company, of New York City, for whom I was general foreman. The new spans were erected and the old removed by the Seaboard Construction Company. A. R. Dunn was the representative of the Pennsylvania Lines on the work, under G. LeBoutillier, division engineer.

HENRY D. HAMMOND.

Warwood, W. Va.

Eliminating Eccentric Loading on Building Foundations

SIR: Having in mind my note on the demolition of the Tower Building in New York City, in your issue of June 27, page 743, this building being the first attempt in skeleton building in New York, it is also of interest at this time to point out the first attempt to eliminate eccentric loading on the foundations of a building in this city. Eccentric loading originated in the old type of wall-bearing buildings with stepped-up brick foundations (because of the limitation of city lot or property lines) and had become an accepted form of construction.



TRUSS TO DISTRIBUTE FOUNDATION LOAD

It was, therefore, a marked departure from previous architectural practice when about 1890, in building an addition to the Western Union Telegraph Company's building just west of Broadway and Dey Street, the architect, H. J. Hardenbergh, to secure a uniform pressure over the soil, introduced riveted, wrought-iron trusses, one story deep, extending entirely across the lot, as shown in the accompanying diagram. The demolition of this building has progressed to such an extent that these trusses are now exposed to view.

This particular foundation is mentioned in the Transactions of the American Society of Civil Engineers, Vol. 27, September, 1892, in the discussion of a paper by H. H. Quimby on "Wind Bracing in High Buildings." The contractor for the work was the then well-known Jackson Architectural Iron Works, the writer being at the time chief engineer of the company.

GEO. A. JUST,
Consulting Engineer.

Long Island City, N. Y.

Economic Design of Penstocks

SIR: Prof. M. L. Enger's deductions on the economic design of penstocks, in the issue of Sept. 12, page 300, provoke the following remarks from one who has had to do with penstock designs: The formulæ are based on the assumption that the annual maintenance and depreciation charges are in proportion to the weight. Evidently these charges, which are most important, are rather in proportion to the surface exposed. It would probably be hard to convince a thoughtful designer or careful paymaster that maintenance and depreciation are the same for a penstock with ¼-in. metal and one having four or five times that wall thickness.

CHARLES R. STEINER.

Long Island City, N. Y.

[This letter was submitted to Professor Enger, whose reply follows.—EDITOR.]

SIR: Mr. Steiner brings out an interesting point, and one that will modify the results in the article referred to. It is customary to use a constant average rate of depreciation, because very little definite information as to the effect of the thickness of the metal of the pipe upon the annual depreciation is available. That depreciation varies directly as the area of the exposed surface is certainly open to question, but it is probably nearer to the truth than to assume that the deprecation is independent of the thickness.

Since the exposed surface per foot of length varies directly as the diameter of the penstock, and since for any given head the diameter varies inversely as the thickness of the pipe, it is evident that under a given head the exposed surface varies inversely as the thickness of the pipe. Assuming depreciation to vary directly as the exposed area,

$$\text{Annual Depreciation} = k/t$$

where k is the annual depreciation when the thickness is 1 in. and t is the thickness in inches. If i is taken as the rate of interest, and r the value of the interest plus depreciation,

$$r = i + k/t.$$

This value of r may be substituted in equations (1) and (4) in the paper referred to. The form of equation (4) will not be changed, but the value of the economic diameter calculated from it will depend on the value of r.

As an illustration the relative diameters of parts of a penstock whose thickness varies from ¼ to 1¼ in. has been calculated on two assumptions—(a) that the depreciation varies as the exposed surface according to the expression $0.025/t$, and that interest is 0.05; (b) that the average depreciation is 0.033 and that interest is 0.05. The results are tabulated below, giving the relative economic diameters in terms of the diameter of the ¼-in. section calculated under the first assumption. An inspection of the table shows that the variation in diameter is less when the depreciation is taken as proportional to the exposed area than when it is taken as constant.

RELATIVE ECONOMIC DIAMETERS IN TERMS OF DIAMETER OF ¼ INCH SECTION

Thickness t, inches	Depreciation $0.025/t$	Interest plus depreciation $0.05+(0.025/t)$	Relative diameter $r=0.05+0.025/t$	Relative diameter $r=0.083$
¼	0.100	0.150	1.000	1.104
⅜	0.067	0.117	0.974	1.029
½	0.050	0.100	0.953	0.980
⅝	0.040	0.090	0.935	0.944
¾	0.033	0.083	0.919	0.919
⅞	0.029	0.079	0.903	0.893
1	0.025	0.075	0.891	0.873
1⅛	0.022	0.072	0.880	0.856
1¼	0.020	0.070	0.868	0.842

The law of depreciation suggested by Mr. Steiner will change Adams' theorem to read: "That pipe fulfils the requirements of greatest economy wherein the value of the energy lost in frictional resistances equals four-tenths of the annual interest plus two-tenths of the annual depreciation of the pipe line."

In the opinion of the writer the value of the depreciation would most probably be found to lie between the two values used in the calculations, and hence the economic diameter would lie between the values found by the two methods of calculation.

Urbana, Ill. M. L. ENGER.

Rational Methods and Guesswork in Sewer Design

SIR: The selection of the size of sewers, to which you called attention on Oct. 17, page 420, is a problem requiring estimates of a number of quantities affected by future changes in population, habits of the people, water supply, industries, and surface conditions, as well as by the character of the construction of the sewers and the amount of ground-water leaking into them. Each of these elements of influence on the total quantity of sewage and water to be carried away can be investigated satisfactorily if funds are provided for the study, and the provision to be made for each during a period of 20 to 30 years can be determined with an approach to accuracy which answers every practical purpose. Hence we do not see any reason for making a sewer one-third or one-half larger than is needed to carry away the maximum quantity of sewage and water which, it is estimated, will ever reach it.

We reviewed the subject critically in preparing our treatise on "American Sewerage Practice" [to be published shortly] and believe that the following quotation from the first volume outlines the best practice in this important feature of sewerage design:

"In order to have capacity for an occasional unexpected condition, lateral pipe sewers are sometimes figured as running half full when carrying the maximum quantity of sewage which it is assumed will reach them. Some engineers have continued this policy until pipes as large as 18 in. have been reached, and in computing this size they have provided for a depth of only seven-tenths of the diameter, using larger sizes when the quantity to be carried exceeds the capacity at this depth, and in each case using seven-tenths of the diameter as the position of the hydraulic gradient. It appears to the authors to be more logical to make allowances for such unusual increments in flow when determining the maximum quantity to be provided for, bearing in mind that the size of the pipe must be such as to provide self-cleansing velocities under usual conditions of flow, and to figure the sewers as running full."

This is one of the details of sewerage design upon which there is a variety of views, and a full discussion of it will be interesting. HARRISON P. EDDY.

Boston.

Broken Sprinklers at Salem

SIR: The statements mentioned in the editorial "Broken Sprinklers at Salem," in the Engineering Record of Sept. 26, page 340, are not in accord with the facts of the Salem fire. The breakage of the public service water connection to the two sprinklered risks spoken of did not occur until about 3.30 p. m., nearly two hours after the fire started. And this breakage did not begin the demoralization of the fire-fighting service; that began one hour and forty-five minutes earlier. According to the report of competent engineers, the first fire company to get into action had to retire almost immediately. Another company tried to connect up a chuck hydrant a block away, and finding it defective had to beat a retreat. In the meantime the fire burned without the least restraint. The day was hot and dry and the heat radiated by the fire was fearful. These conditions of course resulted in the opening of hundreds of sprinklers in the Keefe and Carr tanneries, and they did not open in vain. These sprinklers contested the progress of the fire in the Keefe and Carr factories for a considerable period. The attack of the fire on these factories began between 1.49 and 1.55 p. m., and the riser pipes did not fall until about 3.30 p. m.

The authors of the paper referred to entirely overlook the fact that there were many connections with the public water service other than the sprinkler connections. Five tanneries and leather plants were burned in Blubber Hollow. Two of them were sprinklered. All of them used water, particularly the tanneries—and tanneries use considerable water. These plants had regular service connections, some of them possibly as large as 6 in. These connections were independent of the sprinkler connections and added much to the wastage.

It is obviously stretching the imagination to charge that the difference between 8585 gal. and 2500 gal. per minute is due to broken sprinkler connections when numerous cascades from various broken and melted connections were to be seen after the fire had swept on its way. Moreover, it is difficult to reconcile the statement that 2500 gal. per minute was the limit of the amount of water pumped when there were twenty-five steam and gasoline pumping engines at work in various sections of the city. Other and competent engineers estimated that the maximum water consumption during the fire was at the rate of 17,700 gal. per minute.

The low pressures — the minimum was 10 lb. for one hour—were not the sole result of broken sprinkler connections. In a report on the Salem fire Franklin H. Wentworth, secretary of the National Fire Protection Association, says: "The abundant water supplies of Peabody, Danvers and Beverly were gingerly tied into the Salem system in fear that the pressure they had to contribute would shatter Salem's obsolete old mains and end the water-throwing for good. With water enough to raft Salem out to sea her citizens on the borders of the fire zone threw away their garden hose and extinguished the sparks on their shingle roofs with tree-spraying outfits."

In the report of the inspection department of the Associated Factory Mutual Fire Insurance Companies is this comment: "There was apparently some hesitancy about turning in the higher pressures from surrounding towns until it was apparent that there was sufficient draft from the Salem mains so that the pressure would not build up."

Broken sprinkler connections should not be the "bone of contention" regarding the Salem fire. To be sure, they broke and wasted water, but that was not a "lesson" of the Salem fire. The desirability of positive control of connections between public water service mains and sprinkler systems in buildings cannot be gainsaid, but the arguments for this desirability cannot be strengthened by the happenings in Salem, for the building in which the fire began was not equipped with sprinklers and the pressure began to drop an hour and a half before the sprinkler connections broke. And the conflagration was burning blocks beyond the Carr and Keefe plants when the connections did break.

The one thing in the Salem water system reported excellent by the National Board Engineers in 1907 was the spacing of gate valves. Why was it that an engineer of an organization of fire insurance companies had to direct the closing of the sprinkler connection valve at the Carr plant at 5.00 p. m., one hour and a half after the sprinkler risers went down? Surely there must have been valves in the public mains outside the fire zone which could have been closed.

Inspector Ames, in his report to the Underwriters' Bureau of New England, said: "There was no time when the steamers lacked a water supply." Evidently the breaks in the sprinkler-system connections did not hopelessly cripple the water service. And if the broken sprinkler systems had been immediately shut off and the pressure restored to normal conditions, what then? Franklin Wentworth answers the question: "Water from hose streams never yet stopped nor extinguished a conflagration."

And the fact will bear repeating that there would not have been any sprinkler system breaks to talk about if the Korn factory had been equipped with automatic sprinklers.

I. G. HOAGLAND,
Secretary, National Automatic Sprinkler Association.
New York City.